Northern Transitions

Volume I

Northern Resource
and
Land Use Policy Study

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Northern Resources: A Study of Constraints, Conflicts, and Alternatives

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I Introduction

(a) Objectives of this Study

In the Canadian North, most developments have been based on the exploitation of a single resource for maximum return on investment over a limited life span. This practice results in boom-and-bust development, the inevitable consequences of which have been degradation of the land and disruption of social communities. Statutes and policies to ensure balanced development and conservation are lacking at all levels of government. Few provisions exist for participation by the public when important decisions have to be made, and fewer still to ensure that the public is well informed prior to participation. Resource conflicts have usually become evident only after a proposed industrial or public works project is well advanced, since it has only been necessary for the developers to demonstrate that a proposal is technologically feasible and economically profitable for preparations for construction to ensue automatically. Consequently, most impact studies that are subsequently undertaken to predict environmental and sociological effects are oriented toward the mitigation of some undesirable consequences that may result from the project. The desirability of the project itself is seldom, if ever, questioned; nor are other options for resource use considered before a decision is made, since the base-line is the project itself.

In December 1973 the federal Cabinet established an Environmental Assessment and Review Process (EARP). The three stated objectives and the entire screening process clearly endorse the past policy of decision-making. That there has been no change in that policy is evident from the adjustments to EARP that were approved by Cabinet in February 1977.[1] It is *a priori* assumed that a given project is the best use of the land and resources. The project is not evaluated in relation to other options. Such a policy ensures the wasteful expenditure of public money on impact studies,

Note: This paper deals with events up to August 1977.

thus drastically limiting the possibility of financing studies that might identify and evaluate options in relation to the capacity of the land and to social needs within the whole northern and Canadian context. The assumptions questioned by Mr Justice Thomas Berger illuminate the inadequacy of Cabinet's directive for the whole process of environmental assessment:

> *There is a myth that terms and conditions that will protect the environment can be imposed, no matter how large a project is proposed. There is a feeling that, with enough studies and reports, and once enough evidence is accumulated, somehow all will be well. It is an assumption that implies the choice we intend to make.*[2]

As was indicated in the Introduction to this volume, Phase II of CARC's Northern Resource and Land Use Policy Study had the following objectives:

1. *To demonstrate that better prediction and avoidance of resource use conflicts can be accomplished if the resource use comparisons are based on intrinsic features of northern ecosystems, instead of the present practice where each specific industrial or public works proposal becomes the reference base for identification of conflict areas.*
2. *To demonstrate the important relationships between diverse features of various ecosystems and long-term social values.*

The assumptions that are implicit in these statements are that the biological resources of such ecosystems are vulnerable and of primary sociological importance. If this were not so, there could be no conflict. Documentation of these social-environmental relationships makes those assumptions explicit. However, to demonstrate such relationships as an historical or present-day fact would be profitable only to future historians, if the problem of the meaning of those relationships in a rapidly changing world were ignored.

The relationship of social values to environmental features can be used to predict and avoid or reduce conflict inherent in different kinds of land use, both at the level of mitigation of adverse effects and at the more fundamental level of defining the kinds of land use that are acceptable in a given area. In the case of the proposed Mackenzie Valley Pipeline, an example of the latter form of prediction and avoidance of conflict is found in Berger's recommendation that no industrial activity be permitted in the northern Yukon; while examples of the former kind of prediction and reduction or avoidance of conflict are contained in Berger's recommendations in the second volume of his report regarding conditions to be imposed on construction of a pipeline along the Mackenzie Valley. However, recommendations at either level may not be accepted if the process of making decisions is dominated by policies made in the South and by Canadian patterns of consumption. If the criteria for making decisions concerning resource use are those of feasibility and economic profit, then unless those criteria (with all that they imply) are considered critically, alternatives for land use planning will be neither identified nor considered.

If Phase II of the Northern Resource and Land Use Policy Study is to be of full value, it is clear that the objectives must be considered within the context of an awareness of the nature of different resources, of human and biophysical constraints, and of the criteria involved in making decisions. Given this perspective, examples of conflicts in the use of resources in three regions north of 60° will be considered. Three detailed reports, as yet unpublished, were prepared for the three regions studied, and were the basis for the summaries presented here. Although technical information on the physical and biological environment is fully referenced in the three background reports, it is not included in the summaries. References are, however, presented for the sections of this paper that deal with developments and potential conflicts in the three regions.

(b) Resources

The failure of the Environmental Assessment and Review Process to give equal consideration to different kinds of resources, when decisions regarding land use are made, is basically due to a widespread lack of understanding of the nature and integration of resources and of the diversity of needs that they fulfil. We lack a clear system of classification of resources. Our concepts therefore differ, and this is a matter of concern not only as a source of conflict and confusion but because our options for action are contingent on our concepts. There are those who, with great solemnity, neatly divide the non-human world into two categories — "resources" and "environment" — and never the twain shall meet. This division has for years been enshrined in economic doctrine. That it is economically profitable to consider resources as being, in some mystical way, distinct from the environment is obvious, if only because it has permitted the concept of "external costs" to remain unexamined for so long.

In this report the word "resources" is defined as the complex that forms our life-supporting system. Hence, resources are the means of fulfilling needs. Who or what is in need does not have to be specified. And while it is natural for man to think of resource use as *his* use of resources, it is worth remembering that all living things, including man, are resources during their life and at their death to other living things.

Resources are usually classed as renewable or non-renewable and sometimes as recyclable, but without any consensus as to what resources fall into which categories and why. Fuller discussed some of the difficulties associated with this division on the basis of properties of resources, biophysical laws, and perception of resources.[3] In this report the terms renewable, non-renewable, and recyclable will be used, but the properties and integration of resources that are assigned to these categories will be outlined briefly, so that the remainder of the report may be understood from this perspective.

Living organisms are the only truly renewable resources. They are renewable because they contain genetic information and are therefore capable of controlled growth and of reproduction. Their level of organization is highly complex, but their basic components are recyclable. When broken down by decomposing organisms, these components normally enter the natural recycling processes, during the course of which they become temporarily part of other living organisms. In natural systems "wastes" do not exist, since components become resources for other organisms. On a global scale, water is a non-renewable resource but fresh water is recyclable. Much of the earth's water is entropically unavailable to man, because of the presence of dissolved salts in seawater.[4] However, solar energy makes fresh, "clean" water available through evaporation and transportation, followed by precipitation and run-off.

Bedrock is a non-renewable resource from which the inorganic components of soils are derived. Bedrock may also contain concentrated deposits of ore. These deposits, like bedrock itself, are not recyclable; but metals obtained from them may be recyclable if, as Frosch observed, the use of the metal is non-degrading. For example, copper used as wire may be easily recovered; but if it has been degraded by conversion through use in other commodities, the energetic cost of recovery may be exorbitant. It becomes entropically unavailable.[5] Components of commodities, and even some commodities such as paper, may therefore be recycled by man, thus extending their "life" or period of usefulness to man. Such extension will retard the rate of our depletion of the resources from which they are derived. The limiting factor in such recycling is the cost in energy. Without recycling, however, used commodities accumulate as "wastes." Some of the components of such commodities may be degraded and released into the air, soil, or water, but often in such concentrations that, even if they are not toxic, they may exceed the absorption tolerance threshold of the system into which they are released.

Energy, whatever its source, is a resource with unique properties. It is a force that flows through, and may be temporarily contained in, all resources; but apart from the chemical energy in food, energy that can be used by man is available in two forms. It may be concentrated, as in coal deposits or oil (hydrocarbons), or dispersed, as in solar radiation. The use of concentrated forms of energy results in their depletion and in the dispersal or accumulation of by-products such as carbon dioxide, sulfur dioxide, or radioactive materials and heat. The use of dispersed energy is regulated by availability and the rate of flow, while the only by-product is heat. No form of energy can be re-used at the same level of organization, since the direction of change is irreversible. However, solar energy and its derivative, wind energy, cannot be depleted since the rate of flow is on a cosmic time scale.

A classification of resources based on common properties also requires an understanding of their integration. Frosch indicated the complexity of integration in his consideration of "common heritage properties":

> *. . . not only the fish in the sea, and the plants and animals of the land, but the productive capability of the sea and land; not only the stock of species of plants and animals that are used, but the genetic resources contained in those that are not now used; not only the lumber and land potentials of forests, but their role in maintaining global climate; the property of the ozone layer as an ultraviolet filter; the nature of the global climate itself. In effect we have had to stretch the old meanings of resource to encompass the global properties that make our life possible.*[6]

While fulfilling material needs, the same resource may also fulfil needs at the level of perception. Such resources may then be called aesthetic, intellectual, emotional, or spiritual, according to the form of perception. Such perceptions are not limited to any ethnic group, nor to any class of society.

Prediction of conflicts concerning the use of resources requires an awareness of the different levels of organization of their basic components, of irreversible directions of change, of rates of change, and of natural cycles. Soil erosion, for instance, is a natural and irreversible change; but it is a change that, according to vegetative cover, occurs generally, over a long period of time. Accelerated rates of soil erosion over large areas destroy the ability of the land to support life. Similarly, the extinction of living species is a natural phenomenon, but accelerated rates of extinction may be equally disastrous. The kind of reasoning resulting from a lack of such awareness was shown by the Science Council of Canada: "Energy is the ultimate resource. Given sufficient energy we can obtain supplies of all other resources."[7] When species become extinct, energy cannot reverse that irreversible fact. Energy cannot bring back genetic resources. The application of energy to form soil from bedrock requires a consideration of the time scale that will allow development of the whole macro and micro soil community. Neither can energy bring back the aesthetic or spiritual resources of the lands and waters of the North, if they have been destroyed in the search for more energy. If energy were to be considered as the Science Council suggested, then the development of, for instance, a hydro project on a northern river would automatically preclude consideration of all other resources related to the integrity of that river system.

Clearly the ways in which we think about resources and the extent to which we understand their nature will determine the ways in which we use them.

(c) Criteria Involved in Resource Development Decisions

In science it is axiomatic that the difference between good and poor research lies initially in the questions that are asked. This principle applies as well to the process of making decisions. It is also axiomatic that not merely the logic of an argument be examined, but that the assumptions on which that argument is based be questioned. Given acceptance of a set of assumptions, the number of possible decisions that can be made is restricted accordingly. If conflicts and alternatives concerning northern resources are to be considered rationally, the assumptions on which the criteria for making decisions are based must be examined. This chapter contains comments on only a few selected assumptions that are involved in the criteria of economics, sociology, and ecology. However, since it was stated initially that, given technological feasibility, economic profit has been the only criterion by which proposals concerning resource use have been judged, it is necessary first to present evidence for that statement and then to determine whether there has been any change in policy.

The North has long been considered a region with great material wealth available for the taking; whether the chosen resources were whales, beaver, gold, oil, or uranium, the ideology underlying economic motivation has always been that of "the system of the commons" that was described by Hardin in 1968.[8] Implicit in the system of the commons is a commitment to growth. An economic system committed to growth maximizes the rate of "throughput," that is, the conversion of resources to commodities to wastes. In the absence of effective human protest, such a system must eventually self-destruct, since it ignores the essential finiteness and relatedness of resources and the nature and even existence of biophysical laws. Henderson argued that present economic conceptual models measure the wrong variables and map a vanished system.[9] It is clearly of relevance to this study to ask whether a sound basis for land use planning in the North is possible, given unquestioning acceptance of an economic system committed to growth.

Rea, in tracing the political economy of northern development, described a history of exploitation and export of specific northern resources with the support and active participation of government, and an acceptance of the tradition of economic growth.[10] Rea distinguished between his use of the terms "economic growth" and "economic development." He associated the former with primary extractive industries without regional diversification, whereas economic development was described as the introduction of secondary manufacturing and processing within a region.[11] Such development is dependent on the primary industries, however, and does not *necessarily* exclude growth. For example, introduction of a smelter, as has been suggested for the Yukon, would inevitably result in an increase in growth of the mining industry.

In its assessment of northern decision-making, the Science Council of Canada's Committee on Northern Development found that the economic concerns of the "core actors" largely permeated the decision-making process, while other concerns had only an inferior supportive position. In addition, some affected parties had difficulty in influencing the process, and there was no provision for comprehensive analysis of all major issues.[12] In a background study for that report, Gibson found that the actual practice of decision-making in the Strathcona Sound mining project contradicted government policy, as expressed in the March 1972 policy document on northern development and the December 1973 Cabinet directive on environmental impact assessment.[13] The Strathcona decision was the first to be made concerning a resource extraction project subsequent to the adoption of the new policies.

Although the objective given priority in the March 1972 policy document on northern development was "To provide for a higher standard of living, quality of life and equality of opportunity for northern residents by methods which are compatible with their own preferences and aspirations," the third objective was "To encourage viable economic development within regions of the Northern Territories so as to realize their potential contribution to the national economy and the material well-being of Canadians." Economic development has been seen by the Department of Indian Affairs and Northern Development (DIAND) as being dependent almost exclusively on the mining and oil industries. After dismissing the potential for renewable resource development, the policy stated: "a realistic assessment is that in major terms that can affect the overall wealth of Canada, the economic future of the North lies in the ground." [14] Development of renewable resources may be compatible with the preferences and aspirations of the indigenous population, but it is not a means for quickly realizing large monetary profit. The conflicts inherent in the first and third objectives are not examined, but are hidden in rhetoric, as was evident in a statement made by Barry Yates in 1972, when he was director of the Northern Economic Development Branch of DIAND:

> *The Canadian North has substantial as yet largely undiscovered oil and gas resources which are being vigorously sought out by industry, in response to North American energy demands, under a regulatory structure which encourages exploration but which will ensure a proper return to the owner of these resources, the Canadian public. The key to this development is the balance which must be maintained between the extraction of the resources and the preservation of the environment, recognizing that at all times it is the needs of people that must predominate.* [15]

Which needs? Which people? What is a proper return for loss of a way of life, or for loss of future options? If extraction of non-renewable resources involves destruction of other resources, what is meant by "preservation of the environment"?

Such questions have not been addressed by DIAND. Instead, where conflicts occur, priority continues to be given to the extractive industries, as was illustrated by the response of Warren Allmand to the community of Tuktoyaktuk which requested, through the Committee for Original Peoples' Entitlement (COPE), a land freeze, pending land claims settlement for the Mackenzie Delta. Mr Allmand replied, "While I cannot accept a total freeze on development related activity I can agree that environmental controls on this type of activity should be adequate to ensure the continued use of the area for traditional pursuits." [16] Consequently, under Section 20.1.C of the Territorial Land Use Regulations (TLUR), a six-month deferral of a decision on an application by Gulf Oil for an exploration permit in the area was granted, pending a report by a consultant hired by DIAND. On completion of the report and submission of the views of the councils and hunters and trappers concerned, Mr Allmand stated that he would decide on the precise areas to be protected and the form of that protection: "It must be clearly understood that once this review is completed and special protection in place exploration will be permitted under the appropriate environmental conditions." [17] Clearly the possibility that adequate protection might require *no* exploration activity in the area did not, in Mr Allmand's mind, exist. A similar response was made to the Hunters and Trappers Association of Baker Lake and will be discussed later in this report.

As yet there is no indication of change in either the federal or territorial governments' policy of giving priority to the extractive industries, which means priority to economic growth. While recognizing the importance of participatory democracy and accountability, it is evident that such considerations alone will not change decisions that rest on economic assumptions. Or, as Beakhust testified:

> *To create the trappings of political independence in a reality of economic domination can only produce frustration, suspicion, and eventually anger and hostility. . . . A major theme of my evidence is that a concern with political development compels us to concern ourselves with economic control.* [18]

A basic assumption of our growth-oriented economic system is that resources are infinite because there are no known limits to technology. [19] As soon as one resource becomes scarce, it can be substituted by another. That assumption was brought into question with the publication of *The Limits to Growth*, [20] but nevertheless it is still widely accepted. Because most economists have persisted in thinking of resources as having a single function, they have become incapable of grasping the concept that resources and environment are coextensive. As Henderson observed, "The theory of continual substitution is over-optimistic and does not deal with simultaneous rates of depletion across a whole range of resources." [21] A single resource can supply many different needs; it is therefore impossible to devise a complete substitute. Technology can only devise substitutes for specific functions of resources and, in doing so, must use other resources in new ways. Historically, we have supplied some substitutes for single functions of depleted resources, but this is no argument for infinity.

A second assumption is that economic growth is necessary to create jobs. Incentives are offered to increase rates of consumption so that the consequent increase in rates of production will increase employment opportunities. In the North, Berger found that the native people "are challenging the economic religion of our time, the belief in an ever-expanding cycle of growth and consumption."[22] Economic growth, whether under a capitalist or communist regime, is dependent on industrial growth. Industrial growth creates certain kinds of employment opportunities, but in doing so destroys others. As McTaggart Cowan observed, diversity is sacrificed to a spurious efficiency and loss of diversity inevitably reduces the number of opportunities open to future generations.[23] Such loss diminishes the possibility of balancing industrial mass-production with diverse alternative forms of production. Experience in the North has shown that while the extractive industries may create jobs in the short term, the jobs usually go to skilled southern workers. Some native northerners may learn new skills and find employment, but after the resources are extracted, as inevitably they must be, those skills are of no use to them if they wish to continue to live in their own communities. The effect of industrial development on employment was considered carefully by Berger:

> *The point is simple enough: the extension of the industrial system creates unemployment as well as employment. In an industrial economy there is virtually no alternative to a livelihood based on wage employment. Those who are unable or unprepared to work for wages become unemployed and then dependent on welfare. To the extent that the development of the northern frontier undermines the possibilities of self-employment provided by hunting, fishing and trapping, employment and unemployment will go hand-in-hand.*[24]

The argument that an industrial project *must* be developed in order to create jobs is untenable in a society capable of forming concepts that allow alternatives, both in the conditions for creating employment and in the nature of the employment created. To question the assumption that economic growth (and therefore industrial growth) is necessary to create jobs, means asking what evidence there is to suggest that growth – even in the short term – is the *only* way, and what evidence there is to suggest that it can be sustained in the long term.

A third assumption is that economic goals are necessarily coextensive with social goals. This assumption is generally rejected in principle but not in practice.[25] Economic goals and economic conditions are relatively easy to define and measure. Social goals and social well-being are not. However, the one social goal that was expressed repeatedly in the community hearings of the Mackenzie Valley Pipeline Inquiry was the attainment by individuals of a measure of control over the course of their own lives. Such attainment requires a range of alternatives from which to choose. The economic goals of industrial growth demand conformity to the industrial system, and therefore an impoverished range of choices. Many socially undesirable and unavoidable effects of industrial growth in the North have been discussed by Berger,[26] Sharp,[27] and Gibson.[28] However, the social problems germane to a growth economy oriented towards large-scale industrial developments are apparent throughout all of the industrial world. They have been documented and discussed by such economists as Galbraith, Mishan, Schumacher, Daly, Georgescu-Roegen, and Heilbroner;[29] and by non-economists such as Goldsmith, Taylor, and Commoner.[30]

The demand for industrial growth in the North results from the imperative of industrial growth in the South. Northern gas, for instance, is intended almost exclusively for southern markets. Decisions concerning development of northern resources are profoundly influenced by southern patterns of consumption. The extent to which alternatives to industrial growth are available in the North will therefore be either facilitated or obstructed by the extent to which such alternatives are available in the South. In his study of *Land Management in the Canadian North,* Beauchamp made the following statement:

> *Although some interest groups will not consider it, the initial question is whether or not "northern development" as the term is traditionally used, is a valid end at all. In other words, should the standards of economic success and industrial expansion which dominate the Canadian lifestyle in the South be the primary measurements of northern progress?*[31]

Should they be the primary measurements of southern progress? Because as long as they are, the North has little, if any, choice.

Because of its overriding importance in decisions regarding resources and land use, the criterion of economic growth has been considered in some detail. However, consideration must also be given to social and ecological criteria.

A frequent assumption in the use of social criteria is that social goals can be attained and maintained by technological innovation alone, that we are no longer dependent on the land. The history of man is in one sense the history of his ability to circumvent biophysical constraints. But circumvention always involves some cost, the full payment of which is almost always deferred.

Probably one of the most disastrous circumventions has been the development of a highly industrialized agriculture in North America. Crop production has become a capital- and energy-intensive industry, with the energy input (excluding solar radiation for photosynthesis) coming from petroleum. Taking corn as an example, Pimentel documented that the ratio of energy obtained from corn to the energy used in the process of production declined from 3.24 kilocalories per hectare in 1945 to 2.52 kilocalories per hectare in 1970.[32] Because the yields per hectare for crops have increased, we congratulate ourselves on our efficiency but fail to count the costs. More obvious costs include loss of top soil by erosion at the annual rate of 44.1 metric tons per hectare under corn production and 22.6 metric tons per hectare under wheat production; whereas only 0.7 metric tons per hectare are lost under both continuous bluegrass rangeland and mature forest. The total energy input that was required for corn production in 1945 was approximately equal to the energy input for nitrogen fertilizer alone for corn production in 1970. Pimentel estimated that if the known reserves of petroleum were used solely to feed a world population of four billion at an average annual U.S. diet, these reserves would be exhausted in thirteen years. While exact estimates may be debated, the trend is clear. In addition to the loss of top soil by erosion, and the replacement of nutrients by a finite energy resource, there is also the cost of the export of nutrients from a cropland ecosystem to an urban system. These are obvious costs, and there are others which are more indirect, but the greatest and most insidious cost is the fostering of a belief that there are no limits, or no immediate limits, to our ability to feed the world's population; that there will always be a new technological "breakthrough"; or that equitable distribution will solve everything. Two conclusions can be drawn from this example. First, we are still very much dependent on the land, and second, responsible circumvention requires that we first count the costs and determine when and by whom they will be paid.

It is also necessary to question the assumption that "the greatest good for the greatest number" is in fact, in the long run, the greatest good. There are bills that the majority does not have the right to ask the minority to pay. Or if it does, it had better make very clear the ethical basis for that right and that it is not simply the "right of might." Presumably the assumption of the greatest good for the greatest number was the basis for the acquiescence of the majority of Canadians in such decisions as the W.A.C. Bennett Dam and the James Bay Development. In the latter case, Mr Justice Albert Malouf of the Quebec Superior Court imposed an injunction on construction. His ruling was reversed by the Quebec Court of Appeals, which stated:

> *C'est donc l'intérêt public et général du peuple du Québec qui s'oppose à l'intérêt d'environ deux mille de ses habitants. Nous sommes d'avis que les deux intérêts en présence ne souffrent pas la comparaison.*[33]

The "greatest good" sounds impressive but does not accommodate itself to definition. It is only possible to infer what is meant by the term, from the context in which it is implicitly assumed. Approximately one hundred years ago George Henry Kingsley wrote from the western plains of the United States, to his wife in England:

> *I really fear that they [the Indians] will have to be wiped out if they will not settle and be civilized — and they won't! The world cannot afford to give up enormous tracts of valuable land in order to enable a few bands of wandering savages to live in idleness.*[34]

The world could not afford it because Europe could no longer support its population on its own resource base. The greatest good was, and still is, material wealth — "enormous tracts of valuable land." Obviously a degree of material wealth is necessary for the well-being of the individual, but we still have to face the question of how much is too much. And Canadians, whatever their ethnic origin, need to think seriously about the inevitable consequences of allowing our population or the demands of that population to exceed its resource base.

Finally, it is also necessary to consider some implicit assumptions that are made in the use of ecological criteria. The assumption that man is dependent on the land not only for his material well-being, but also for his psychological well-being, has been demonstrated repeatedly by statements made by human beings of diverse ethnic origin and various degrees of formal education. These statements all have to do with feeling, and often with feeling that is associated with experience of beauty.

A second assumption is that man is subject to the laws of evolution which are far more complex, subtle, and comprehensive than is indicated by the phrase, "survival of the fittest," and which include cultural as well as biological evolution. Social Darwinism, as propounded by Spencer, is a distortion of the concept of evolution by natural selection. It has no foundation in scientific fact, since competition between species or individuals is only one force in the evolutionary process. In any consideration of evolution it is necessary to remember that competition also occurs between conflicting drives within the same individual; that co-operation is also a phenomenon of evolution; and that no individual or species is independent of others. Biotic and social communities also evolve by natural selection. Man is part of both a social community and the biotic community of the world. The necessity for stressing such relationships becomes clear from Aldo Leopold's statement in 1949: "All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts."[35] As a member of such a community, man is not only responsible for his actions but is responsible for attempting to understand the effects of his actions before decisions are made. As A.N. Whitehead stated, "Duty arises from our potential control over the course of events. Where attainable knowledge could have changed the issue, ignorance has the guilt of vice." It is necessary to emphasize that ethical behaviour is only observed within the community which an individual recognizes. If there is no sense of community, there is no sense of responsibility.

Assumptions implicit in ecological criteria indicate concern for the survival and the well-being of man and of the conditions under which, in the words of Leiss, "we can discover some of the abundant sources of satisfaction that have lain untapped so long."[36]

(d) Some Basic Requirements for Northern Planning

The need for comprehensive planning in the North has been stressed recently by Naysmith[37] and Beauchamp.[38] In particular, Beauchamp urged that decisions to use the lands and energy resources of the North be made as part of a strategic plan for development that includes human and ecological components, and values other than those relating solely to growth and production. He found that present land use policies are dominated by the industrial forces which impose a single use on all northern lands in the process of exploration for and development of minerals; and that the land is being treated as only incidental to the short-term benefits to be gained by the extraction of non-renewable resources. He concluded that, as a preliminary step, a detailed inventory and analysis of land and resources must form the basis for rational and comprehensive planning.

Clearly, options for land use cannot be identified, much less evaluated, without a knowledge of the diverse resources of different regions, the productive and protective capacity of the land, and human values in relation to the land. While the information we possess is detailed in some instances and fragmentary in others, a tenet of this study is that better use can be made of existing knowledge. Accordingly, information from publications and from some unpublished material was compiled for three regions in the North (Figure 1). These regions comprise some of the different biotic communities that are characteristic of northern ecosystems. Their boundaries are arbitrary and they are not in themselves ecosystems. The detailed reports that resulted form the basis for the summaries in the following three sections.

II The Bear Rock-Brackett Lake Region

(a) Description of the Area

The Bear Rock-Brackett Lake region is in the Mackenzie District of the Northwest Territories (Figure 2). It includes the confluence of the Great Bear and Mackenzie rivers, part of the Norman and eastern Franklin ranges, and the wetlands lying between those ranges and north of Great Bear River to Kelly Lake. This area, subsequently call the defined region, is in the subarctic climatic zone and has an average of 115 days free of a killing frost. Mean annual precipitation is 28.2 centimetres with maximum precipitation occurring in August. It lies within the zone of widespread but discontinuous permafrost. Bedrock outcrops occur along parts of the eastern Franklin and Norman ranges. Norman Range terminates in the historic landmark of Bear Rock, above the confluence of the Mackenzie and Great Bear rivers. Geological formations indicate the probability of some oil in the region, and coal deposits have long been known. Glacial tills and thin silts and clays overlain by organic matter are the predominant soils in the region, the stability of which varies according to plant cover, presence of permafrost, slope, and aspect. The wetland complex comprises shallow, thermokarst lakes, marshes, and muskeg. The water table is

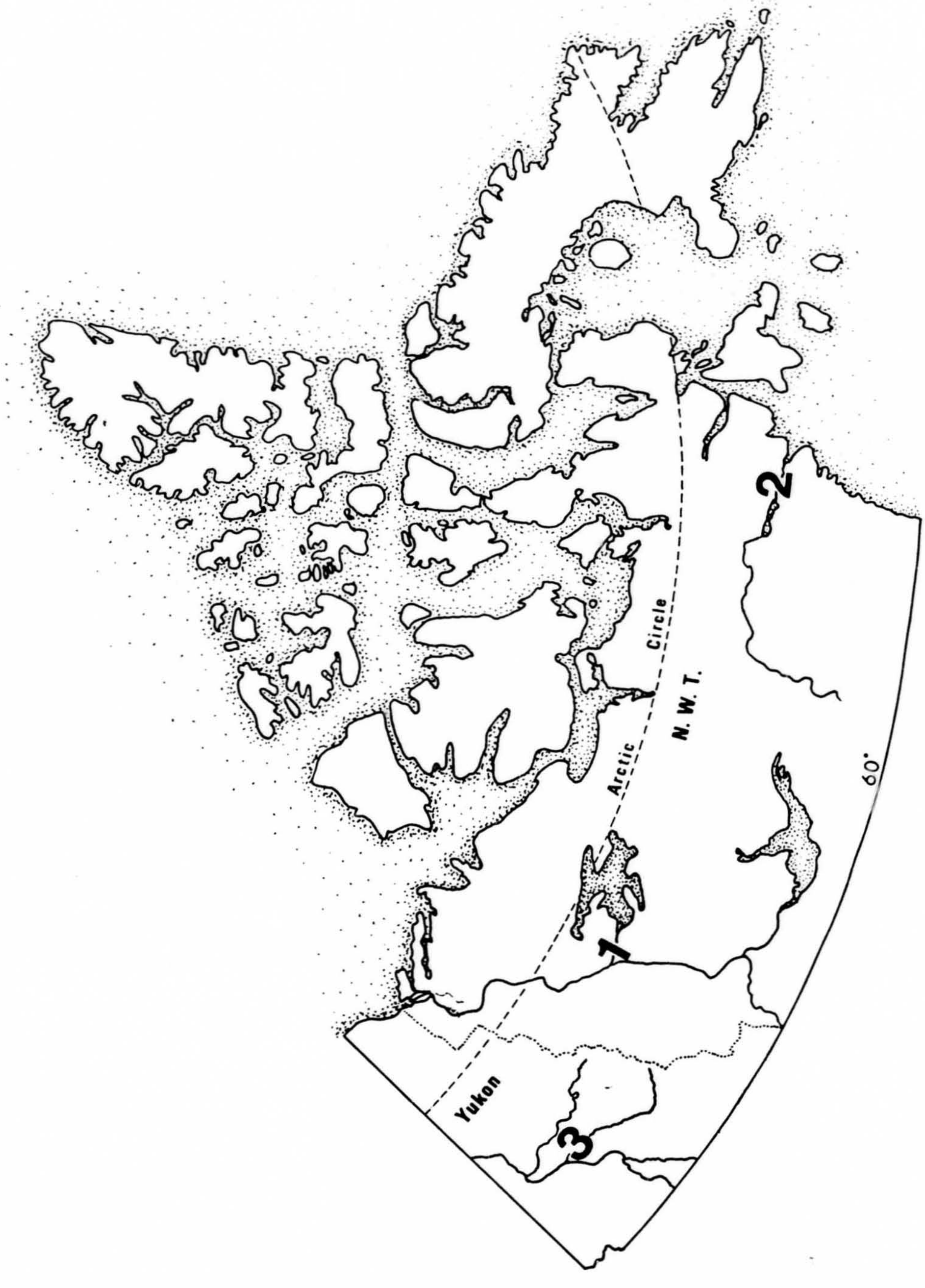


Figure 1 Location of Three Defined Regions

1 Bear Rock–Brackett Lake
2 Baker Lake–Chesterfield Inlet
3 Pelly–Macmillan Rivers

high. Ground seepage and ground springs are fairly numerous within the region and in winter cause overflow of ice that may persist on some slopes into July.

Great Bear River is a major eastern tributary of the Mackenzie River. It is unique in that it forms a barrier-free connection between one of the largest lakes in North America and the only major river in the continent that flows northward. Like that of most of the tributaries that flow into the Mackenzie River from the east, the water of the Great Bear River is clear and cold throughout the year. The riverbed is composed of gravel with cobble and boulders. Ice breakup in spring occurs about ten days later than that of the Mackenzie River. Areas of open water in winter occur in Great Bear River, Loche River, Brackett River, and some of the creeks draining the western slopes of the Norman Range. These areas are important to overwintering fish and also to otter in the Loche and Brackett rivers.

The three most abundant species of fish in the defined region are arctic grayling, longnose sucker, and northern pike. The greatest number of fish species occurs in the Mackenzie River near the mouth of the Great Bear River, where cold, clear water mixes with the warmer, more turbid water of the Mackenzie River. Some species, such as lake trout and humpback whitefish, may be locally very abundant in lakes within the defined region. Spring-spawning fish include grayling, walleye, northern pike, longnose sucker, and trout-perch. These spawn before or slightly after ice breakup and the eggs hatch about ten to twenty days later. The critical period for spawning and incubation in this region is 1 May to 15 July. The critical period for fall-spawning fish is 10 August to 15 November. Eggs of fall spawners hatch the following spring. Grayling, inconnu, walleye, and lake trout require silt-free substrate and high levels of dissolved oxygen for successful reproduction. Many of the other species in the defined region can tolerate some siltation and lower oxygen levels. Northern pike are unique in that they require spawning substrates with flooded vegetation for successful reproduction. Spring flooding of muskeg lowlands in the Brackett River drainage is therefore probably important for pike.

Apart from spawning areas, other requirements are nursery and feeding areas, overwintering areas, and migration routes for free access between these different habitats. The Mackenzie River is a primary migration route for grayling and inconnu. The back eddies and creek mouths along the river are important nursery and feeding areas for inconnu and walleye. The Great Bear River is a primary migration route in spring and fall and a nursery, feeding, and probably overwintering area for many species. Extensive gravel beds and clear, well-oxygenated water provide excellent spawning conditions for grayling. Of the abundant grayling population, some are year-round residents, while others that spawn in tributaries of the Mackenzie River outside the defined region stay within the Great Bear River for the rest of the year. The Great Bear River may be one of the most important areas for grayling in the Mackenzie region. Fisheries biologists class it as a critical aquatic ecosystem, in terms of being vital to the survival of significant numbers of important fish species, and consider it highly sensitive to technological disturbance. Such disturbance includes increased siltation from land erosion, spills of oil, petroleum products, and toxic substances and eutrophication. In the defined region Vermilion Creek is classed as an important aquatic ecosystem and sensitive to technological disturbance throughout the year. Most of the Brackett Lake wetlands complex is also considered to be sensitive to technological disturbance. Kelly Lake is an important aquatic ecosystem, providing essential habitats for major year-round populations of northern pike, humpback whitefish, and lake trout.

Domestic fishing sites and associated camps are shown in Figure 3. Kelly Lake has long been used for domestic fishing and more recently for sports fishing. The outlet at Loche River is a traditional fall-to-winter fishing area. Brackett Lake and the Mackenzie and Great Bear rivers are also traditional areas for domestic fishing. In addition, Fort Franklin residents fish the Great Bear River in June, July, and August. Fish are a traditional source of protein for native peoples and a major food for such dog teams as still exist in the region.

The Mackenzie River is not only a primary migration route for fish; its valley is one of the major flyways in Canada for migratory birds. In spring, concentrations of staging waterbirds are dependent on areas of open water. Open water occurs early, during breakup, around shallow shorelines, sand bars, in old meander channels and snyes, and around islands, as well as in the mouths of some tributary streams. In the defined region Halfway and Windy islands are included in one of the major staging areas, with snow geese being especially abundant in this area and immediately downstream. The Brackett Lake wetlands complex is considered to be an important early spring staging area for whistling swans, as well as one of the most productive areas in the Mackenzie Valley for ducks, loons, and shorebirds.

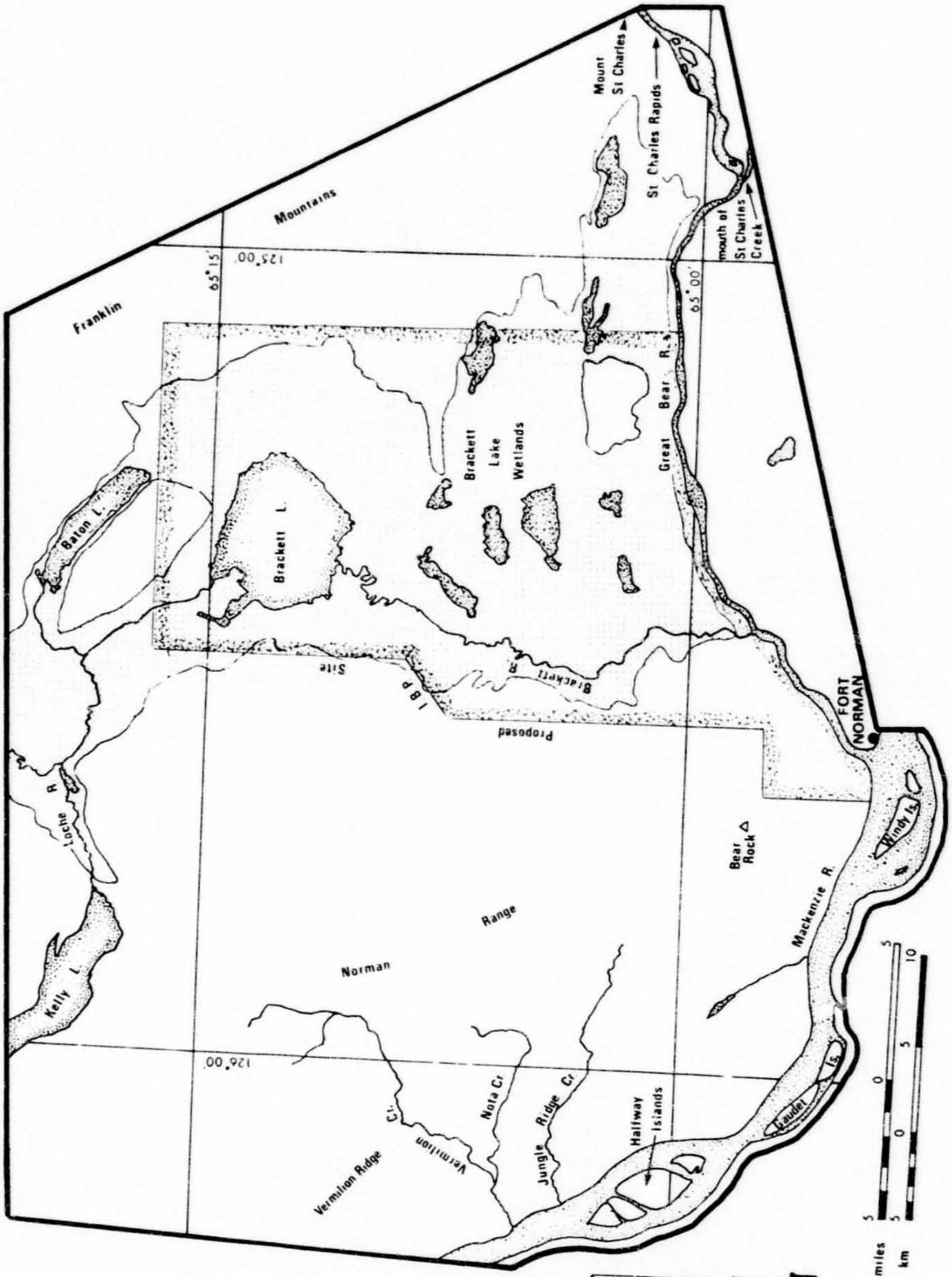
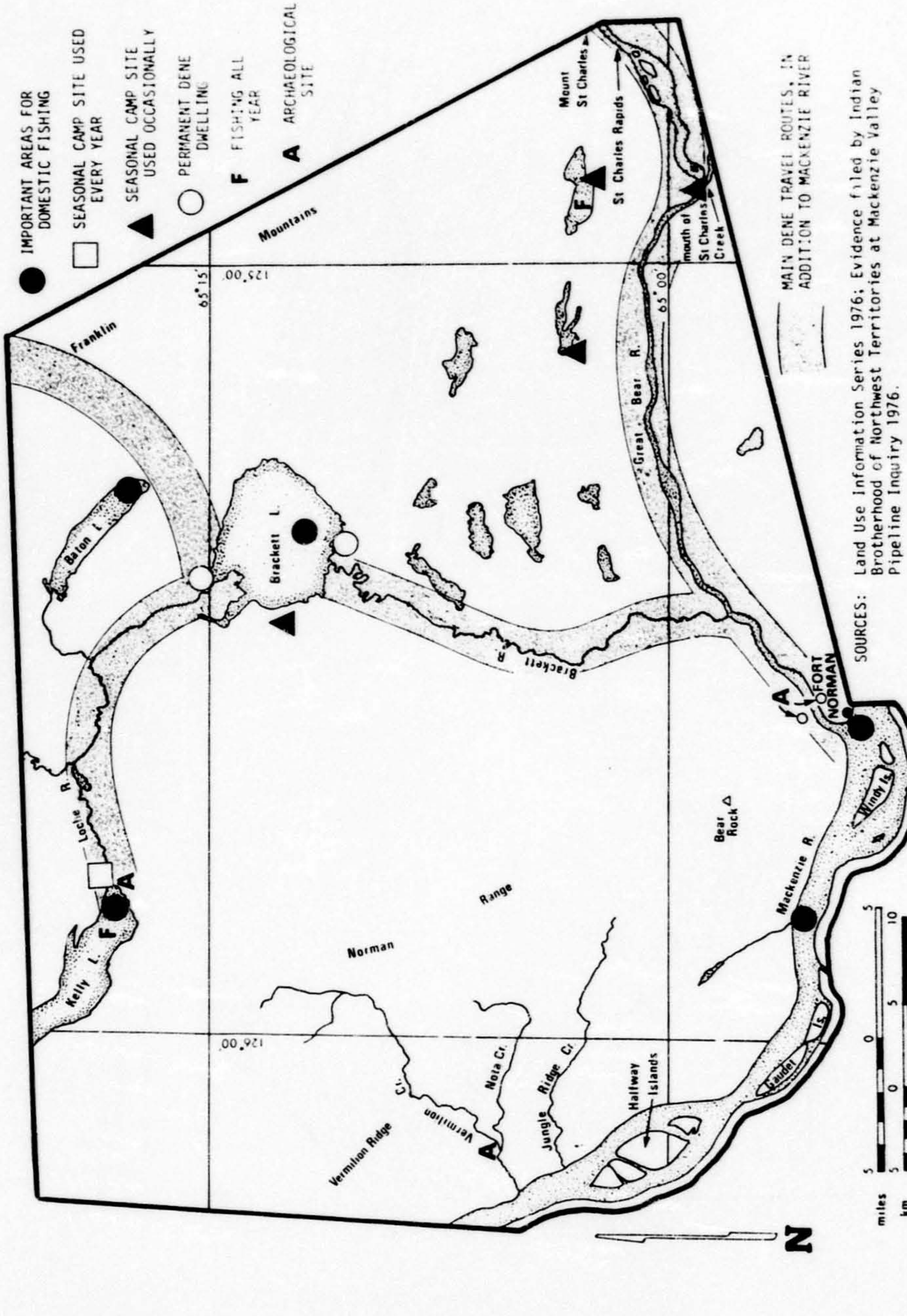


Figure 2 Bear Rock–Brackett Lake Region

Brackett Lake Wetlands shown in dotted area.



SOURCES: Land Use Information Series 1976; Evidence filed by Indian Brotherhood of Northwest Territories at Mackenzie Valley Pipeline Inquiry 1976.

Figure 3 Dene Land Use in Bear Rock–Brackett Lake Region

and a critical moulting and late summer staging area for many species of waterfowl. Its importance for nesting waterfowl may be increased during periods of drought in the prairies. Its importance as a fall staging area for arctic nesting waterbirds is probably high in all years, but may be critical in years when staging in the coastal region is curtailed by poor weather conditions.

Diurnal birds of prey that are summer residents or migrants in the defined region include two declining or endangered species – bald eagle and peregrine falcon. They are associated respectively with fish and waterfowl, and therefore with rivers, lakes, wetlands, and migration routes. Bald eagles usually nest in trees and are not restricted by nesting habitat, while peregrine falcons, south of the tundra, nest in cliffs near water. The availability of such habitat in the Mackenzie Valley is largely confined to the middle and lower regions. In the defined region peregrine falcons are known to nest in the Franklin Mountains, and the Norman Range is classed as a zone of regional importance to raptors (birds of prey). Ptarmigan and grouse are found in areas such as the north bank of the Great Bear River, where deciduous shrubs are in close proximity to black and white spruce, providing food and shelter.

Waterfowl, ptarmigan, and grouse are hunted for food by local residents. Scoters are the only species of waterfowl in the defined region that may be taken legally by Indians during the summer. Their eggs may also be taken. September and October are the months of open season for ducks and geese in the Territories.

The Mackenzie River valley allows northward extension of the true boreal forest. This forest is confined to the river valley, the lower slopes of the Norman Range, and the lower part of the valley of the Great Bear River. Lightning is the major cause of fires, with July being the most hazardous month. Fires in some locations have initiated slumping and flow slides, with consequent siltation of rivers. Fires, however, do not burn uniformly, and while decreasing suitable habitat for some animals, such as marten, they have increased it for others, such as moose. The wetlands and adjacent hills have been subject to fires of varying extent and intensity in different years. Regeneration in burned areas has resulted in plant communities that are in successional stages of growth and change. The wetlands are also subject to flooding during and following spring breakup, as are parts of the shoreline and islands of the Mackenzie River. Seasonal flooding maintains successional stages of riparian plant communities. These communities are characterized by high biological productivity, together with a relatively high diversity of species. They are stable (but not static) because the plant and animal components have evolved in relation to this form of physical disturbance. In the Mackenzie Valley region, the number of moose is considered to be limited by the amount of suitable winter habitat. Winter habitat is important for moose since, like many other northern wild ungulates, they reduce their food intake and operate on a negative energy balance during winter. They minimize energy loss by staying in sheltered areas where heat loss from wind chill is reduced, and close to an abundant food source so that minimal energy is expended in moving through deep snow in search of food. Repeated disturbance, associated or unassociated with hunting, will increase energy expenditure if moose are forced to move frequently. If winter conditions are severe, or if moose do not enter the winter in good condition, their chances of survival are accordingly decreased.

Winter habitat occurs in river valleys, wetlands, and parts of upland slopes. Halfway, Gaudet, and Windy islands in the Mackenzie River have a high potential winter carrying capacity for moose, but because of their proximity to Fort Norman they have been heavily hunted and constitute one of the "moose vacuums" along the Mackenzie River. Islands of apparently similar carrying capacity, but less easily accessible, were observed to have late winter densities of 2.1 to 3.5 moose per square mile. There are no estimates of densities of moose in the defined region. On a regional basis, the islands in the vicinity of Fort Norman are classed as important winter range, and the Brackett Lake wetland complex as very important winter range because of its size and the lack of winter habitat in much of the surrounding area. Moose are an important resource to Indians of the region for food and for clothing such as mitts and moccasins.

Movements of woodland caribou during winter are governed to a greater extent than those of moose by the density and depth of snow. Little is known about populations east of the Mackenzie River. In the defined region their range overlaps with the winter range of moose in the Loche River area, where caribou were stated to be abundant. The Bluenose herd of barren ground caribou is essentially found east of the Franklin Mountains and outside the defined region. Recently, men from Fort Norman have also hunted barren ground caribou in spring, by joining Bear Lake men from Fort Franklin and travelling by chartered aircraft to the Colville Lake area. Community hunts for woodland caribou have also been made in areas west of the Mackenzie River.

Of the fur-bearers in the defined region, beaver, muskrat, and snowshoe hare are also traditional sources of food. Snowshoe hares are generally snared, and their fur is cut into strips and woven. The fur was once used extensively by Hare Indian groups, but recently only for trimming. Snowshoe hares are a substantial source of meat in years when their numbers are high. In the wetlands, beaver and muskrat are hunted from canoes in spring and may be trapped in winter. In the North, beaver are limited by suitable lodge or bank denning sites where water levels are adequate, and where there is sufficient growth of poplar or willow close enough to the site to be transported and stored in feed rafts for winter. In some areas abundant production of water lilies may provide an alternative source of food during winter. Both denning sites and food requirements are dependent on natural physical processes that affect water levels of lakes and streams, riparian succession, depth of the active layer in areas of permafrost, and bank stability. Water depth is critical to both beaver and muskrat. Where beaver can control water levels by dams, conditions for muskrats are enhanced. Such dams affect many species of animals by changing water conditions and plant succession. Changes, however, are usually temporary and occur on a small scale in clumped or scattered areas. Beaver have a dynamic effect on their surroundings. The Brackett Lake wetlands are classed among the best habitat for beaver and muskrat in the Mackenzie Valley region. The Mackenzie Delta is good muskrat habitat, but much of it is less favourable for beaver, and only four other areas in the Mackenzie Valley are classed as good habitat. Populations of both beaver and muskrat have fluctuated in the defined region over the years, and there are no recent estimates of densities.

Other fur-bearers in the defined region include marten, fox, lynx, mink, weasel, wolverine, wolf, and black bear. Marten occur on the slopes of the Franklin Mountains and hills adjacent to the wetlands, and on the uplands surrounding Kelly Lake. They generally prefer mature coniferous forest and avoid burned areas for a variable number of years. They are easy to trap because of their curiosity. In the past they have been completely trapped out of some areas and may be slow to return, since their reproductive potential is not high. The status of marten in the defined region is not known, nor is that of the other fur-bearers.

The defined region is used by Dene from Fort Norman, Fort Franklin, and Fort Good Hope. Major routes of travel and campsites are shown in Figure 3. There are many other trails within the wetlands and crossing the Norman and eastern Franklin ranges. The defined region is used by full-time and part-time trappers, and cabins are located at Brackett Lake. Concentration of people in settlements, with requirements for children to attend school, and the absence of any stability in fur prices have added to the difficulties inherent in trapping. Nevertheless, values associated with the independence and self-reliance of bush life, with country food, and with the need to maintain some contact with the land, were repeatedly expressed at the Fort Norman and Brackett Lake community hearings of the Mackenzie Valley Pipeline Inquiry.

(b) Some Current and Proposed Developments

Extension of the Mackenzie Highway

Construction of an all-weather highway, linking Inuvik with the planned extension of the Dempster Highway and the Liard and Mackenzie highways at Fort Simpson, was started in the winter of 1971. An all-weather highway had been proposed in the mid-1960s, but since so many other proposals of development in the North were made in that decade it was apparently not taken very seriously by the Canadian public or press. Although sections were built in the winter of 1971 between Fort McPherson and Arctic Red River and for thirty-three miles south of Inuvik, little if any publicity was given to this development in the context of a Mackenzie Valley Highway. The full extent of the proposed development was publicly announced by Prime Minister Trudeau in April 1972 and was extensively covered by the press. The stage to which surveying, clearing, and construction had proceeded by the fall of 1973 was described by Wolford.[39] Since then, construction has slowed and scheduling is uncertain. In the defined region, routing of the highway was planned to follow the CNT telephone line. Because of a critical shortage of good quality construction material south of Great Bear River, however, Underwood, McLellan and Associates Ltd. were commissioned by the federal Department of Public Works to investigate the feasibility of alternative routes between Saline River (Mile 521) and Bear Rock (Mile 588). Their report was published in May 1973.[40] One alternative route runs parallel to the Great Bear River from St Charles Creek to approximately one kilometre below the mouth of the Brackett River, where it crosses the Great Bear River and continues to the narrow pass behind Bear Rock. Because of greater distance and cost, this route was not recommended. The other alternative joins the CNT line south of the defined region and crosses the Great Bear River approximately one and a half kilometres above the mouth of that river before continuing to the same pass. Canadian Arctic Gas Study Ltd. showed the

Mackenzie Highway crossing the Great Bear River approximately four kilometres above the river mouth.[41]

After construction of the highway had begun, assessment of the design and routing was undertaken by the Mackenzie Highway Environmental Working Group of the federal government. In March 1974 this group proposed future monitoring studies. In the group's proposal, it was stated that "the Mackenzie Highway is being subjected to a systematic environmental examination during the course of its design and construction." In other words, a final design review was made during and after the course of construction, contrary to the policy stated in the Environmental Assessment and Review Process.

Pipeline Transportation of Oil and Gas

Following the oil and gas discoveries in Prudhoe Bay, investigation of the technical feasibility of an oil pipeline from Prudhoe Bay to Edmonton was undertaken in 1969 by Mackenzie Valley Pipeline Research Ltd. In the same year the Northwest Project Study Group and Gas Arctic Study Ltd. started feasibility studies on natural gas transport by pipeline. In 1972 these companies amalgamated to form Canadian Arctic Gas Study Ltd. (CAGSL), and in March 1974 they filed application with the Department of Indian Affairs and Northern Development and the National Energy Board to begin construction of a gas pipeline. A similar application was later filed by Foothills Pipe Lines Ltd. Environmental and social impact studies were undertaken principally by Environment Canada, the Department of Energy, Mines and Resources, the Department of Indian Affairs and Northern Development, consulting companies hired by CAGSL, and the Environment Protection Board which was funded by CAGSL. The Mackenzie Valley Pipeline Inquiry was established in March 1974, at which time Mr Justice Thomas Berger was appointed commissioner. Formal and community hearings were completed in November 1976, and Mr Justice Berger's recommendations to the Minister of Indian Affairs and Northern Development were published in 1977. Under the terms of reference for the inquiry, the applications were considered from the perspective of a transportation corridor and the cumulative impact of such development.

In the defined region the gas pipeline route proposed by CAGSL crosses Vermilion, Nota, and Jungle Ridge creeks on the west slope of the Norman Range. The Norman Range itself is crossed by the pass behind Bear Rock and the Great Bear River is crossed at a point approximately four kilometres below the mouth of the Brackett River.[42] The proposal requires a construction camp, compressor station, stockpile, and helipad at Vermilion Creek, with one mile of all-weather access road. Borrow pits and helipads are required in the vicinity of the route, together with a wharf and stockpile at Fort Norman. The route proposed by Foothills through the defined region is similar to that proposed by CAGSL. Transportation of materials by tug and barge down the Mackenzie requires a doubling of the capacity of the present fleet. The extent and nature of the many activities related to construction and maintenance of a gas pipeline were described by Berger. Canadian Arctic Gas Study Ltd. was disbanded in August 1977, but the "Maple Leaf" route proposed by Foothills remains a distinct possibility sometime in the future.

An alternative route running east of the Franklin Mountains was presented by Roed.[43] Construction of such a route would still be dependent on transportation of materials on the Mackenzie River, with a staging area on the Great Bear River at the Bennett Field airstrip. Presumably, transportation of materials from the Mackenzie River up the Great Bear River would either greatly increase barge traffic with associated dredging, or result in pressure for construction of a road.

In relation to the corridor concept, RMC Resources Management Consultants Ltd. recommended to the Government of the Northwest Territories that Fort Norman be developed as a major service area.[44]

Hydro-electric Power

In 1971 the Great Bear River was proposed by the Northern Canada Power Commission (NCPC) for hydro-electric development, and G.E. Crippen and Associates Ltd. undertook a feasibility study which was published in 1972.[45] Five potential dam sites were selected. These are located at Wolverine Creek, the head of the St Charles Rapids, the St Charles Rapids, above the mouth of the Brackett River, and below the mouth of the Brackett River. Thurlow and Associates Ltd. were commissioned to undertake a preliminary environmental impact study of this scheme, a report of which was submitted to the Northwest Territories Water Board in 1973.[46] Baseline data on the fish resources were obtained by the Fisheries and Marine Service, Environment Canada, during studies related to the proposed Mackenzie Valley Pipeline.[47]

On 10 December 1974 a Standing Committee on Indian Affairs and Northern Development met with representatives of the Indian Brotherhood of the Northwest Territories and others to consider Bill C-13, which was a proposal to amend the NCPC Act. The members of the Indian Brotherhood expressed their opposition to Bill C-13, and the then president James Wah-Shee suggested the following amendments:

1. *No dams such as the Great Bear development be allowed in advance of a land settlement and after that only with the consent and approval of the Indian Bands affected.*
2. *All proposed developments be subjected to environmental and social impact assessment by the Department of the Environment, and all reports be made public and tabled before Parliament.*
3. *That the administration of the Northern Inland Waters Act be removed from the Department of Indian Affairs and Northern Development.*
4. *That instead of changing the rate structures as proposed, equalization of rates be achieved by subsidizing.*[48]

Wah-Shee's objections to NCPC being part of the Department of Indian Affairs and Northern Development, which constituted an intolerable conflict of interest, and to the lack of input by the Department of Environment were not answered. However, he was told that it was the understanding of the Standing Committee that the Great Bear hydro scheme had been temporarily "shelved." Owing to this indefinite postponement, an impact study which was to have been undertaken by the Canadian Wildlife Service, on the effects of the scheme on migratory waterfowl, was also indefinitely postponed.[49] The reason given was that the project was to have been funded by the Department of Indian Affairs and Northern Development and the funds were not now available.[50] Why the funding should come from the Department of Indian Affairs and Northern Development, and not from the Department of Environment of which the Canadian Wildlife Service is a division, is somewhat obscure in view of the Department of Environment's international responsibility for migratory birds.

Exploration for Petroleum and Coal Resources

Nine petroleum exploration companies hold exploration permits in the defined region.[51] Aquitaine Company of Canada Ltd. has the most intensive holdings, and by 1975 had spent more than two million dollars in the search for oil and gas.[52] The entire wetland complex and west slope of the Norman Range are covered by exploration permits. Seismic lines are extensive and some wildcat wells have been drilled.

In 1973 Thurlow and Associates suggested that local coal deposits be considered as an alternative source of power in this region.[53] Manalta Coal Ltd. holds exploration permits in the defined region south of the Great Bear River, as well as over an extensive area to the south. Coal seams have been encountered in a rotary drilling programme, and there is believed to exist a potential for large coal reserves in the Brackett basin.[54]

Parks and Other Reserves

Part of the defined region was proposed as an Ecological Site (Figure 2) through the Canadian Committee for the International Biological Programme (IBP). A formal application was submitted to the Hon. Judd Buchanan, then Minister of Indian Affairs and Northern Development, in September 1975. To date no decision has been reached with respect to the application for this site.

Areas with potential for outdoor recreational development in the defined region were identified on maps of the Land Use Information Series.[55] Sites for camping and family beach activity were located along Kelly Lake near the outlet of the Loche River. Access to Kelly Lake could be attained by jet boat or by air. The lake was also included in a canoe route which covered Loche River, Brackett Lake, Brackett River, and Great Bear River. Areas for sports fishing included the Great Bear River, Brackett Lake, and Kelly Lake. The proposed Mackenzie Highway was considered to have potential for tourists, with scenic views occurring along the Norman Range.

(c) Potential Resource Use Conflicts

The proposed developments outlined in the previous section clearly indicate that various demands will be made upon different resources in the defined region. This section will outline some examples of predictable resource use conflicts.

Exposed bedrock occurs in parts of the Franklin Mountains, including the Norman Range. In some locations, including Bear Rock itself, these outcrops are important for nesting sites of peregrine falcon. G.E. Crippen and Associates indicated in the Great Bear hydro development study that Bear Rock would be a good source of construction material.[56] Underwood, McLellan and Associates also marked Bear Rock as a site for bedrock borrow for construction of the Mackenzie Highway.[57] Furthermore, Bear Rock is proposed as a National Landmark.[58] Clearly, a scenic area that is a possible National Landmark with nesting peregrine falcons is incompatible with the construction of quarries, or with any activity close to nesting sites.

The Great Bear River and St Charles, Bluefish, Vermilion, Nota, and Jungle Ridge creeks all contain clean gravel deposits for most of the length of their beds. This gravel provides spawning areas for such important species as grayling, broad whitefish, arctic cisco, and inconnu. The gravel also provides habitat for clear-water benthic invertebrates which are important food organisms for many fish. For physiological reasons, fish tire faster than mammals and take longer to recuperate. In streams where currents are swift, they require areas of slack water. The microhabitats of a gravel and boulder stream bed provide the necessary areas of slack water for resident fish. Territories of stream-dwelling fish are often associated with visual environmental reference points, such as rocks and boulders.[59]

Crippen and Associates suggested that gravel from the Great Bear River and its tributaries would be the most valuable source of unfrozen construction material for the proposed hydro-electric development.[60] However, the use of stream beds as a source of gravel for any kind of construction is in direct conflict with the maintenance of these areas as important fish habitats. In this part of the Mackenzie Valley, western tributaries are silt-laden and have low densities of fish.[61] The productive eastern tributaries are extremely sensitive to development, and gravel removal or development-caused siltation is completely unacceptable from a fisheries standpoint. Retention of these gravel beds is also necessary if the rivers and streams of this region are to retain their present aesthetic appeal.

The Mackenzie River islands are important to migratory waterbirds in spring and fall, and to moose in late winter. Seasonal flooding often results in alluvial deposits on the downstream end of islands, which form a nutrient-rich, sloping shoreline that favours abundant growth of aquatic plants. The associated water is slack and provides resting areas, escape cover, and food for fish, as well as for those waterfowl which are resident in summer. There is evidence to suggest that some islands have higher populations of voles and deer mice than most mainland areas. These small rodents are an important food source for fur-bearing animals such as weasel, as well as for some raptors. Good stands of white spruce occur both on islands and in river valleys where the soil is relatively rich and well drained. In addition, islands are often protected from mainland fires. In good cone-producing years, white spruce provides abundant food for both squirrels and voles, and birds such as wandering flocks of white-winged crossbills. Such trees also provide nesting sites for bald eagles and osprey. Bald eagles scavenge for fish, and they may have been historically associated with Indian fishing camps as well as with fish spawning areas. Some islands have traditionally been used by Indians for containing sled dogs during the summer. These dogs forage for themselves and may be fed by their owners with catches of fish. It is not known whether any islands in this region have been used in this way.

Because most construction techniques in the North require sand, gravel, and other kinds of aggregate, islands have a high potential for removal of borrow materials, just as with bedrock areas, talus slopes, streambeds, and eskers. Underwood, McLellan and Associates suggested that the Mackenzie River islands near Fort Norman may yield significant quantities of fine to medium well-graded sands for highway construction, but that further test drilling is required for assessment of their potential.[62] Excavation of sand from the islands would obviously be in conflict with the biologically important features of these areas. The extent of conflict would depend on the size and locations of excavation sites and the time of year of removal, none of which information is presently available.

In recent years recreational travel by small craft down the Mackenzie River has increased. Islands are a favoured camping or lunch site, with the windward side offering relief from mosquitoes and black flies, and the leeward side offering relief from storms. This form of recreation is not, for aesthetic reasons, compatible with the noise levels associated either with construction on and around islands or with increased density of land, water, and air vehicles. Nor is it compatible with the scars of borrow pits and access roads. However, recreational travel by small water craft may itself destroy various resources, and its own value, if its level greatly increases.

Although bedrock areas, streambeds, islands, and areas of water are the sites of specific, and often very intense, disturbances by man, it is the well-drained land surfaces that in the long term receive most of the conspicuous disturbances. Settlements, roads, airstrips, landing areas along rivers, storage areas, and most other man-made facilities are normally built on well-drained land surfaces. Not surprisingly, then, the potential for resource use conflicts is great on these portions of the landscape. Roads may intersect traplines or migration routes of animals; the best stands of white spruce occur on well-drained land; gravel pits on ridges or eskers may destroy important wildlife habitat; and various facilities such as roads, pipelines, or railroads may compete for precious space in certain topographically restricted terraces or passes.

In the defined region, both the proposed gas pipeline and the Mackenzie Highway follow the east slope of the Mackenzie Valley, crossing till-plain terrain which includes undifferentiated areas of peat, fen, or peat-fen complex. Zoltai and Pettapiece emphasized that the terrain sensitivity maps provide only a general rating for large areas, and that local variations inevitably occur.[63] Neill noted bank stability problems for routes running parallel to the Mackenzie River on the east bank.[64] Areas subject to large-scale shallow slides included a slope east of Halfway Island. The proposed gas pipeline crosses Vermilion Creek, above which springs ensure a winter flow of water, and the banks of which are classified as unstable. One mile below another spring the proposed pipeline crosses Jungle Ridge Creek, which is a spawning area for grayling, and then runs parallel to the spawning area, although on the downslope side. The highway extension must, by reason of greater terrain sensitivity on the east side of the Norman Range, follow much of the same route. The route of an oil pipeline or a railway would also be subject to similar restrictions.

Silting of river crossings with secondary effects on juvenile fish and therefore tertiary effects on fish harvest has been discussed in relation to the pipeline. But what will be the cumulative effect of two, three, and possibly four lines of transportation within the same relatively narrow area? If all of these are to be constructed along the east side of the Mackenzie River, they must all be funnelled through the narrow pass behind Bear Rock and must all cross the Great Bear River in a restricted area between Fort Norman and the mouth of the Brackett River, the banks of which area are largely unstable.[65] Will the unavoidable environmental effects become additive or synergistic with construction of other transport lines? And can these combined effects still be called minimal even though the effects of any one facility may be "minimal"? CAGSL proposed a construction camp on the north side of Vermilion Creek with a helipad, compressor station, and an access road to Vermilion Ridge for borrow material. If a pipeline were proposed again sometime in the future, would there be competition for borrow material by highway and pipeline construction contractors? Will the highway also run parallel to the Jungle Ridge Creek spawning area for grayling, and will there be room downslope for both pipeline and highway? What will be the effect on the highway of the springs along the west slope of the Norman Range? Maps prepared by van Everdingen indicate widespread occurrence of springs, perennial groundwater discharge into streams, and related spring and stream icings in the corridor between the Mackenzie River and the Norman Range from Bear Rock to Gibson Pass.[66] These springs suggest a high probability that both highway and pipeline will encounter groundwater-related problems in this part of the transportation corridor.

Regardless of which development is being considered, construction will involve access to areas, clearance of rights-of-way, communication between sites, removal of local sources of construction material, transportation of construction materials, crossing of streams, use of heavy equipment, immigration of skilled workers, construction of infrastructures required for temporary worker accommodation and support, and supplies of fuel which must be transported to the construction areas. Many of these activities would generally follow routes over well-drained land surfaces.

The Brackett Lake wetlands include muskeg (fens and peat plateaus) and marshes, as well as lakes and streams with various types of shoreline vegetation. Wetland complexes form an extensive area of land and water interface. The associated soils are often deep and rich in nutrients. Natural changes in plant communities (succession) result in a diversity of plants and associated animals. For these reasons wetlands, with the general exception of muskegs, are among the most biologically productive areas in the world. Hunting, especially for waterfowl, has always been and still is associated with wetlands. In addition to hunting, fishing and more recently trapping continue to be traditional uses of wetlands. In temperate regions, agriculture that requires drainage of marshes has been the overriding form of wetland use; but in the North this is not a foreseeable conflict because of the constraints of climate upon agriculture. Stewart, however, suggested that remote peatlands in the North could provide peat for horticultural production, and also observed that some species of grass "have potential for converting our northern peatlands into more productive pastures once the problem of cultivation on permafrost can be solved — if ever."[67] In regions without permafrost where peatlands have been drained and cultivated, rapid decomposition of the peat occurs, resulting in disappearance of the peat surface. Stewart therefore concluded that peat should be considered a non-renewable resource which allows only short-term cultivation.[68] It would seem that such use of the resource for increased food production is equivalent to the much deplored slash and burn technique of "underdeveloped" countries.

Use of peatlands for treatment of polluted water was discussed by Ruel et al.,[69] and Hartland-Rowe and Wright studied the absorption of wastes from sewage disposal near Hay River, N.W.T.[70] Their findings, however, cannot be extrapolated to all northern wetlands. Muir observed that mine wastes (waste rock slurry) dumped into muskeg near Pine Point had partly buried and killed some coniferous forests, and stated that the long-term results of percolation of wastes through muskeg to Great Slave Lake were not fully understood.[71]

Small-scale removal of peat for local use as a fuel for heating and cooking has been practised for centuries in countries such as Scotland, Ireland, Finland, and Russia. More recently, there has been increased research into the use of peat as a source of paper, construction material, alcohol, and industrial fuel.[72] Peat has successfully been used to absorb oil from oil spills and may be considered for stockpiling along any oil pipeline route. However, removal of peat in permafrost areas of high ice content in the Brackett Lake area, on the scale necessary for stockpiling or industrial uses, would result in severe thermokarst slumping and erosion. In addition, the presence of muskeg accentuates fluctuation in water flow after heavy rainfall and snowmelt.[73] Increased flow after snowmelt is necessary for ice breakup and spring flooding in the defined region and the Mackenzie Delta.

The Brackett Lake wetlands would be entirely unsuitable for any phase of construction related to the Mackenzie Valley corridor concept. However, related to this concept is an expected increase in tourist traffic and increase in resident population along the Mackenzie Valley, if the Mackenzie Highway is completed. In summer and fall, access to the wetlands and to Kelly Lake can be gained easily from Fort Norman by canoe or other small boat. While there is no tourist conflict with use of resources by native people or with research on the proposed IBP Brackett Lake Ecological Site, as long as recreation pressure is light, there is the potential for conflict if such pressure increases.

An indirect conflict for the Brackett Lake wetlands is that which may be associated with hydro development of the Great Bear River. Thurlow and Associates discussed the possible impact of such development on the wetlands, development which might result in changes of groundwater level or in floods from destruction of the levee on the north shore of the Great Bear River.[74] Most of the wetlands are below the 122 metre contour above sea level, and the area is now mapped at 7.6 metre contour intervals. At the Lower Brackett dam site, the river bed is 53.3 metres above sea level. The full supply level of this dam would be 97.5 metres,[75] while the full supply level of the Upper Brackett dam would be 108.2 metres. Again, it must be stressed that the Mackenzie Valley is one of the major North American waterfowl flyways, and that the Brackett Lake wetlands complex is one of only a few wetlands in this region. This fact raises the possibility of various conflicts between proposed developments and long-term maintenance of waterfowl habitat and of beaver and muskrat habitat.

Rivers are systems which evolve from the interactions of flowing water with land. Their diversity of character is formed by this interrelationship, as is the character of the land through which they flow. Seasonal irregularity of flow regimes is a vital factor in the dynamics of terrestrial plant and animal communities along river banks and their mouths or deltas. A brief list of some properties of rivers may suggest why, of all physical features, rivers and their valleys rank highest among areas of potential resource use conflict, particularly in the North:

1 they contain kinetic energy which, depending on the river profile, may be harnessed;
2 they are a medium of transportation for a variety of living organisms, including man;
3 they are a medium of nutrient supply and deposition and are therefore areas of relatively rich soils, especially in the North;
4 they allow the extension northward of the range of some plant and animal communities;
5 they are an essential habitat for fish, waterbirds, and semi-aquatic mammals, and for the migration and dispersal of these animals;
6 for all the foregoing reasons, they are traditionally associated with settlements;
7 they are a source of water supply for settlements and a medium for waste disposal of various kinds;
8 they have a strong aesthetic, emotional, and intellectual appeal to many people.

Presently the transportation needs of people in settlements along the Mackenzie River are served by barge and other boats during the summer, a winter road after freeze-up, and aircraft year-round. Use of air-cushion vehicles has been the subject of experiment in the upper Mackenzie River near Fort Providence and in the Mackenzie Delta. In the future these vehicles may be proposed for limited use in the Fort Norman-Brackett Lake region of the Mackenzie Valley. Jet boats are also used for recreational and other transportation needs in shallow water.

Although the proposed Great Bear River hydro development is now indefinitely postponed, if it is reconsidered there would be road construction from Fort Norman to the proposed dam site. A road would probably be required the entire way from Fort Norman to Great Bear Lake, since the residents of Fort Franklin and Fort Norman would no longer be able to travel on the Great Bear River in summer by canoes with small outboard motors. Most of the local residents own such canoes, and when travelling on the river use the opportunity to hunt. Substitution of a road in place of river transport would require the residents to purchase trucks or cars. If the Lower Brackett dam is built, access by river to the Brackett Lake wetlands area, including Kelly, Loche, and Mahoney lakes, would also be restricted at least to the extent of portaging around the dam. Water levels below the dam would be low and possibly no longer navigable.

Construction of dams on the Great Bear River would block fish migration, although ladders might be built to overcome this problem partially. Culverts associated with stream crossings of access roads can also present serious obstacles to fish migration, depending on the culvert length and also on the rates of water flow through the culverts.[76] A more detailed discussion of the effects of hydro development on fish is given in the section of this paper dealing with the Pelly-Macmillan study area.

The importance of river valleys for resource planning is indicated by a section of the final report of the Pipeline Application Assessment Group.[77] Although this report by a government assessment team was not intended to make recommendations, it does make recommendations regarding certain broad inter-disciplinary matters, such as where it is best to cross a stream to lessen undesirable pipeline effects in valleys. The initiative taken by the Pipeline Application Assessment Group to make recommendations on this important issue seems to be an admission that no agency or group of agencies is now undertaking co-ordinated environmental planning for areas of above-average importance, such as river valleys.

If lakes in this region are developed for commercialized recreational use, the increased fish harvest, increased transportation activity, and general increase in human presence may conflict with the traditional uses of these areas by native people.

If artificial snow is required for snow roads to transport heavy construction equipment in winter, local sources of water will be required for snow making. In winter, water levels in lakes, streams, and rivers are generally low. If water requirements are such that the levels are reduced further, the survival of overwintering fish, muskrat, and beaver may be threatened. Lakes in forested areas that are protected from wind accumulate snow. Removal of such snow for snow roads may result in an increase in the thickness of the ice, because of loss of insulation, and consequently a decrease in the depth of the water. In shallow lakes there may again be an adverse effect on overwintering animals. Removal of snow from terrestrial areas may destroy overwintering habitat for small rodents which are dependent on snow cover for protection from most predators, and for protection from extreme cold. They are a basic component of food chains in the North. Low-growing plants and dormant invertebrates are also dependent on the insulating and protective properties of snow cover. While snow removal may affect relatively small areas, the incremental effect may be important locally.

Exploration for oil and gas requires seismic lines to be cut, blasting, and wildcat wells to be drilled. Exploration for coal involves a programme of rotary drilling. These activities involve transportation of men and machinery over various types of terrain, with locally high levels of noise. The Territorial Land Use Regulations were designed to minimize disturbance to land and waters; but they make no provision for disturbance to animals, nor do they consider cumulative effects of a variety of land use operations.[78] Data on the effects that various activities associated with extractive industries have had on a few species are as yet inadequate to answer questions related to cumulative effects. In relation to the Mackenzie Valley Pipeline Inquiry, the cumulative activities associated with development were described most vividly by Templeton.[79] McTaggart Cowan emphasized the danger of chain reactions that might occur within biotic communities,[80] while Usher and Noble stressed the lack of consideration of the cumulative impact of oil and gas exploration and development on social communities.[81] In short, cumulative impact may give rise to cumulative effects, which may be additive or synergistic and are beyond the ability of science to predict, especially when considered in the context of the stresses imposed by natural changes.

As the preceding examples have indicated, there is considerable potential for resource use conflicts in the Bear Rock-Brackett Lake area.

III The Baker Lake-Chesterfield Inlet Region

(a) Description of the Area

The Baker Lake-Chesterfield Inlet region is in the Keewatin District of the Northwest Territories (Figure 4). It includes a marine coastal area and estuary, a large area of low shrub tundra, and many lakes with rivers draining into the Thelon

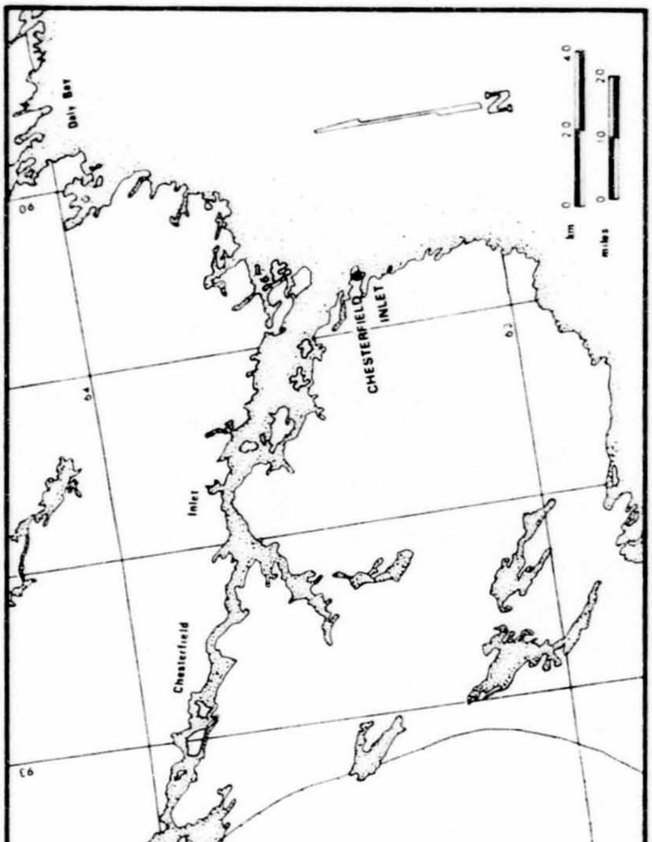


Figure 4 Baker Lake–Chesterfield Inlet Region

system of Baker Lake and Chesterfield Inlet, as well as the headwaters of some rivers draining directly into Hudson Bay. This area, subsequently called the defined region, is within both the arctic and subarctic climatic zone and within the zone of continuous permafrost. Mean annual precipitation is 20.9 centimetres at Baker Lake and 27.8 centimetres at Chesterfield Inlet. July and August are the months of maximum precipitation. Snowfall is relatively light, and prevailing winds cause accumulation of snow in depressions and of packed snow in drifts on the lee side of obstructions, leaving other areas with a shallow snow cover. Ground blizzards, which may produce whiteouts, are common and wind chill values are high. Ice formation in lakes is broken up repeatedly by strong winds, while that at the coast is subject to both tide and wind action. Land-fast ice is separated from drift ice by leads of open water which are estimated to average about five miles in width along the coastal area. Many narrow leads occur north of Chesterfield Inlet in Roes Welcome Sound. The nature and extent of land-fast ice varies according to the roughness of coastline and the presence of islands and reefs, as well as to temperatures, winds, and tides during the freeze-up period. Similarly, snow conditions on the ice will vary according to topographical features and to the roughness of the ice. Land-fast ice is stable in the Chesterfield Inlet region and wider than that which forms south of Eskimo Point.

The land is low-lying, with a general northwest to west orientation. It lies within the Canadian Shield and granitic outcrops are common in some areas. Deposits of copper, lead, silver, and uranium are known, and soapstone also occurs in some locations. Drainage is generally poorly integrated, with the exception of the three major rivers – the Kazan, Thelon, and Quoich. Peak runoff from snowmelt occurs during late June or early July. Winter flows are very low as a result of depletion of lake storage. Many of the lakes in the Kazan drainage basin are shallow, and they and connecting streams may freeze solid. Chesterfield Inlet and Baker Lake are navigable for small ships by the middle or end of July, until the middle or end of October. The lake is shallow on the south side, especially near the mouths of the Kazan and Thelon rivers. Sandy beaches characterize the south shore, while deeper water is found along the north side where outcrops of granitic rocks occur.

A deep narrow trench of approximately a hundred metres in depth occurs at the mouth of Chesterfield Inlet close to the south shore. Shoal waters associated with islands and reefs are common along much of the coast in the defined region. The tidal range at Chesterfield Inlet is 2.9 to 3.2 metres, and tidal flats occur south of the settlement, at Cape Silumiut and along many of the offshore islands. Tidal streams are associated with a rotary progression of tides around Hudson Bay. They are strongest on the west coast and are influenced by the frequent strong winds which are characteristic of Hudson Bay. Currents along the coast in the defined region run southward. Frequent strong winds are also responsible for vertical mixing of waters.

Whitefish, lake trout, and arctic char occur in the fresh-water systems of the defined region. Anadromous char, studied in the Wilson Bay area, had higher rates of growth and matured later than land-locked populations. Char spawn in freshwater on gravel during the late fall when ice is forming. They deposit eggs in 1.8 metres to 4.6 metres of water and in shallow pools below rapids in rivers. There was evidence that both anadromous and land-locked char may spawn only in alternate years. Adult char leave the lakes at first breakup of ice and crowd river floodwaters close to the shore. Although they are of primary importance to Inuit, the study indicated that char are not sufficiently abundant for commercial fishing in that region. Dunbar found that there was some potential for commercial fishing of arctic char in Hudson Bay. However, he recommended that the take in any region be spread over as many streams and stream mouths as possible, and that each region be studied independently and strict limits on the harvests be set.

Lake whitefish and lake trout were studied in Kaminuriak Lake, where a small commercial fishery has existed since 1972. While the growth rate of Kaminuriak whitefish appeared to be moderately high compared to that of whitefish in some other northern lakes, that for trout appeared to be low. A study from 1970 to 1971 showed that lake trout in Kaminuriak Lake had mercury in muscle tissue in excess of 0.5 parts per million. Under the Food and Drug Act and Regulations, 0.5 parts per million of mercury per kilogram of wet weight is the limit for safe consumption, although this limit is subject to revision and is believed to have a wide safety margin. The source of mercury contamination in Kaminuriak Lake is not known, and lake trout in Baker Lake did not show levels in excess of this amount.

The Land Use and Occupancy Study of the Inuit Tapirisat of Canada indicated areas in the defined region where fish were abundant and commonly harvested. These are shown in Figure 5. In a 1972 report by a federal-territorial task force on fisheries development in the Northwest Territories, it was observed that in many unexploited areas

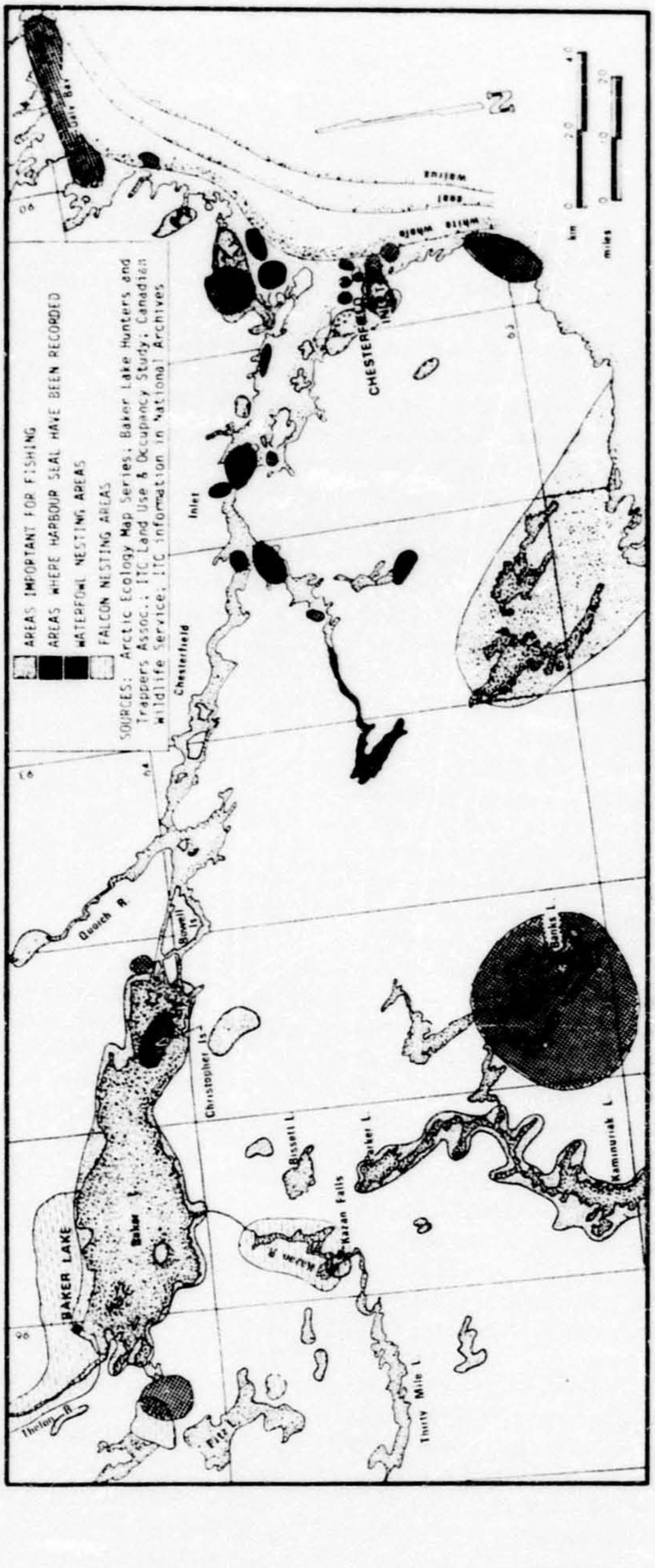


Figure 5 Important Wildlife Areas in Baker Lake–Chesterfield Inlet Region

Outer limits shown for marine mammals.

fish populations appeared to be high, but that these populations represented capital stock with a relatively low sustainable yield. If the biological capital is removed, many years will be required for regeneration, during which time no harvesting can take place. The practice of "mining" fish stocks, which has occurred in the past, was strongly opposed. The task force stated that there was a major risk of overharvesting, especially for the development of freshwater and coastal fisheries in the Arctic. Consequently, both assessment of fish stocks prior to development and regular monitoring of harvested fish stocks were required, so that quota adjustments could be made. If management for a sustainable annual yield was then found to be uneconomical on a commercial basis, the alternative of a six-year harvest cycle could be used, with lakes being fished for two years and lying fallow for four years. The task force concluded that the necessary information was lacking for a comprehensive assessment of productivity and sustainable yield of fish populations in the Northwest Territories, and that there were no comprehensive estimates of the domestic catch of fish.

The task force recommended that fisheries development should be for the benefit of long-term residents of the North, and that harvesting of fish for domestic purposes should take precedence over commercial or sports development. These were value judgments and quite properly so, since decisions cannot be made unless values are explicitly compared. The task force also recognized that domestic supplies of fish protein might profitably compete with imported protein from the South, and that commercial fishing operations could form the basis of inter-settlement trade. In addition, if operated by northern residents, sports fisheries developments would provide a source of northern revenue and yield a greater return on each fish harvested, generally with less stress on the resource. The Rankin Inlet area, part of which is included in the defined region, was recommended for further investigation, although the cannery was considered to be only marginally viable in economic terms.

Geese, ducks, and swans migrate through the defined region. The wetlands from the Kazan Delta to the Thelon Delta are an important staging area in spring and fall for snow and Canada geese. Snow geese nest in small colonies at Kazan Falls and northeast of Pitz Lake. Canada geese nest at low densities in much of the defined region. Nesting Canada geese make use of small islands or hummocks in tundra lakes which afford some protection from terrestrial predators. Non-breeding geese migrate into the defined region for moulting. During a study of areas that are used for moulting, an aggregation of about 3,400 birds was observed in the Quoich River. Habitat suitable for moulting geese is restricted mainly to stream and lake shorelines associated with post-glacial lacustrine or marine submergence. In tributary streams and lakes, moulting geese are always associated with sand beaches and sedge meadows that are flooded in spring. Non-breeding birds arrive soon after ice breakup (early June at Kazan River and late June at Quoich River), with post-breeding birds arriving later. Moulting birds use large amounts of energy and must afterwards accumulate energy reserves for migration south. During moult, which lasts between twenty-five and thirty days, geese are highly susceptible to disturbance, and in the Thelon River were observed to desert prime moulting habitat in subsequent years when repeatedly disturbed. Accordingly, it was recommended that prime moulting areas in the Thelon and Quoich rivers be protected from repetitive boat and airplane use from 15 June to 1 August.

Open leads adjacent to land-fast ice in the defined region may be important staging areas for birds that nest on Southampton Island. Mixed flocks of Canada, white-fronted, and snow geese rest on land-fast ice in the Chesterfield Inlet region, and in spring ducks and geese are hunted all along the floe edge by Inuit from Chesterfield Inlet. Common eider both breed and winter in the defined region. They are dependent on open leads for overwintering, and generally use offshore islands for nesting. Oldsquaw are also common breeders in the area. Red-throated loons commonly nest near the coast and on offshore islands. According to nutrient availability and light penetration, phytoplankton (free-floating plants) may be abundant on the undersurface of ice. This community is grazed by zooplankton (aquatic invertebrates) including, in Hudson Bay, large amphipods which in turn are eaten by such fish as Greenland cod and arctic char. Both invertebrates and fish may be eaten by seabirds at the floe edge. Black guillemot, gulls, and parasitic jaeger were observed to be common at the floe edge in the Chesterfield Inlet area in May. Later in the season, many shorebirds are found along sandy beaches where strands of dry seaweed containing larvae and pupae and marine organisms provide a source of food. The abundance of breeding black guillemot and common eider is thought to be related to the abundance of benthic algae (attached seaweeds) in offshore waters. Areas of shoal water and reefs are numerous in the Chesterfield Inlet region. Benthic algae require a firm substrate and protection from ice scouring within the fluctuating shallow waters of tidal areas (the littoral zone). Such conditions occur only locally in Hudson Bay.

Rock and willow ptarmigan and sandhill cranes nest within the defined region. Ptarmigan are also resident throughout winter. Ptarmigan and waterfowl are hunted by people from the settlements of Baker Lake and Chesterfield Inlet, and guillemot and their eggs may legally be taken by Inuit during the summer.

Kazan Falls, the Thelon River, and areas between Baker Lake and Pitz Lake are important nesting areas for peregrine and, in some instances, gyr falcons. The northwest shore of Baker Lake is defined as a peregrine falcon nesting area, and peregrine falcon have also been observed at Chesterfield Inlet.

Continuous permafrost, poorly developed soils, and the presence of bedrock near the surface result in groundwater being stored in unconsolidated glacial deposits, and numerous surface ponds in low-lying areas. Snowmelt occurs early on the southern aspects of eskers and raised beaches. Water from melting snow runs off the uplands while the soil is still frozen, and early in the season much of the lowlands is swampy. The active layer ranges from one to two metres during the summer. Broad valleys between low hills near the Baker Lake settlement are covered with heaths, lichens, and grasses. Patches of dwarf willow occur on Christopher Island and on nearby mainland hills. Sedge meadows occur in low-lying areas. Productivity in low arctic sedge meadows is generally high (1.16 to 3.56 grams per day), compared to that in the High Arctic. Fires caused by lightning are not uncommon during hot, dry summers, and fires have been observed on all kinds of terrain. Uplands south of Bissett Lake reach an elevation of 183 metres above sea level. While much of the southern part of the defined region is of moderate relief and is usually described as flat and monotonous, there is sufficient difference in topography and therefore in aspect, snow distribution, and patterns of melting to ensure that phenology differs within the defined region – a factor of great importance to both migratory and non-migratory herbivores. The main mammalian herbivores in the defined region are barren ground caribou, lemmings, arctic hares, and arctic ground squirrels.

Barren ground caribou occurring in the defined region appear to belong to two populations, named after their traditional calving areas. These are the Kaminuriak herd and the Beverly herd. A major proportion of both these herds usually winters in the taiga (boreal forest) in northeastern Saskatchewan, northern Manitoba, and the Northwest Territories. A sub-group of the Kaminuriak herd is known to winter on the coast in the Rankin Inlet-Chesterfield Inlet region. While it shares the same general calving area, this group would not appear to share the same breeding area as the taiga wintering population. Calving grounds within, or adjacent to, the defined region are shown in Figure 6. The grounds are generally high and rocky. At the time of calving, lichens are usually abundant on the calving grounds and contain a high percentage of moisture. Synchronized group movements which arise from strong social bonds are believed to induce simultaneous oestrus in females, synchronized conception, and thus a short calving period. The brevity of the calving period in turn reduces the period of vulnerability of females in parturition and of newborn calves to predation by wolves. The peak of calving occurs during the first half of June. Calves are precocious at birth, and double their length in the first five months of life. Rapid growth rates are considered to result from selective feeding on high-quality forage.

Post-calving concentrations occur in late June and July, and are shown in the defined region in Figure 6. Concentrations may occur in wet sedges, and are probably a response to rapid new green growth of sedges at that time. Other post-calving concentrations occur in low shrub tundra where dwarf birch and willow are common. In addition to being a response to the phenological availability of plants of high nutritional quality, post-calving concentrations allow the formation of small social units within the larger group. The discreteness of groups of migratory animals and their affinity to certain localities is not well understood, but it is an integral part of their behaviour adapted to their survival. It would therefore seem apparent that known areas of post-calving concentrations require as much protection as calving areas and migration routes, in terms of avoiding disturbance to both animals and vegetation.

Two migratory movements within the defined region were not observed in recent biological studies of the Kaminuriak herd. These are a spring crossing of the Kazan River below the Kazan Falls and a summer crossing of Chesterfield Inlet at the narrows. Manning observed caribou tracks on Christopher Island in late August 1945, and was informed by Corporal Hamilton of the RCMP at Baker Lake that he had seen large numbers of caribou crossing Chesterfield Inlet at its western end in 1944. Inuit of Chesterfield Inlet and Baker Lake maintain that this is a traditional crossing area. In September 1903, Low observed a camp of Inuit at the channel south of Bowell Island, where

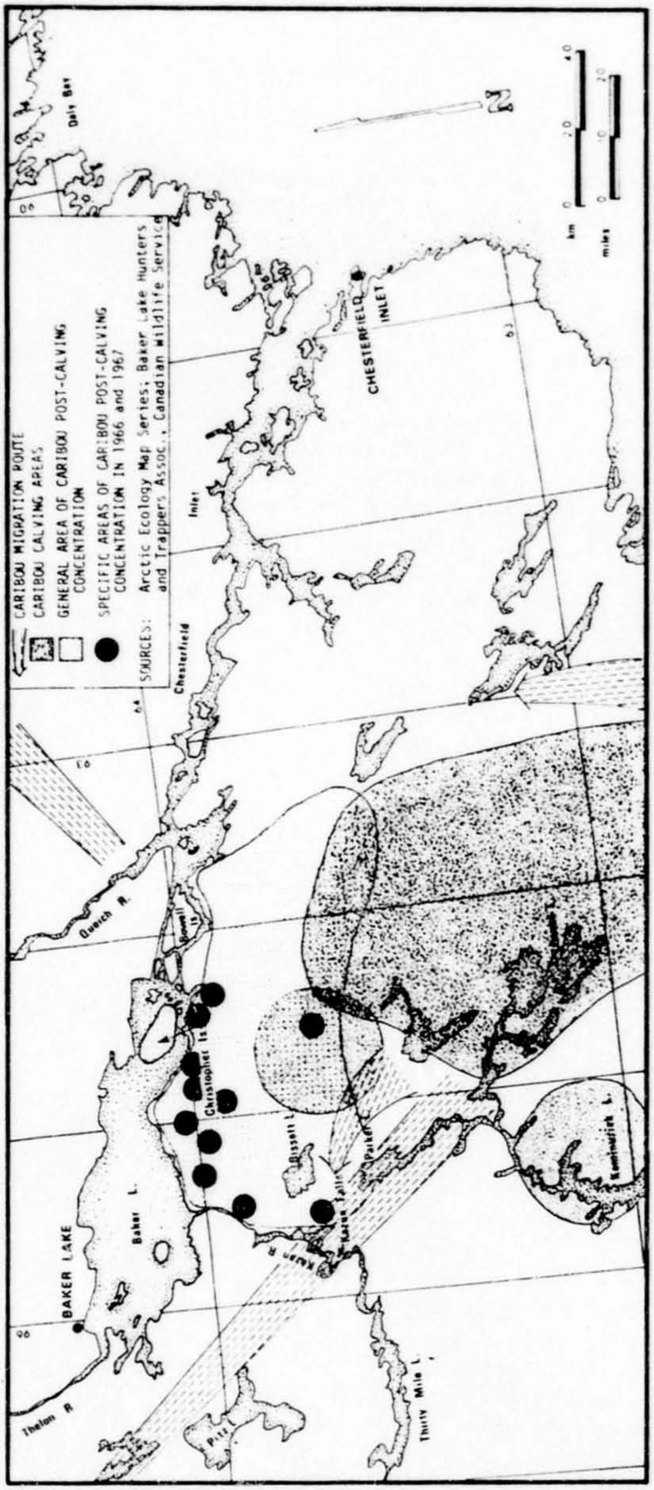


Figure 6 Important Caribou Areas in Baker Lake–Chesterfield Inlet Regio

great numbers of caribou had been killed at the crossing. North of Chesterfield Inlet caribou occur year round and are hunted by Inuit. Hunting areas show the north side of Chesterfield Inlet to be heavily hunted, and a small area on both sides of the lower Kazan River to be within caribou hunting range. It is not known whether the Kazan River crossing is no longer used because of natural shrinkage of caribou range following changes in population, or because of disturbance by activities associated with mineral exploration and maintenance of camps.

Estimates of mainland barren ground caribou populations, derived by various techniques, suggest a population decline from the 1940s through the 1950s and an increase in the early 1960s. However, data from aerial surveys made in 1955 and 1967-68 were analyzed and it was found that, when techniques of extrapolation were adjusted to make such a comparison valid, there was no evidence for an increase in population over this period of time. The Kaminuriak population was estimated at 63,000 in 1968 and the Beverly population at 159,000 in 1967. Analysis of the population structure of the Kaminuriak herd indicated a stable herd with a potential for rapid increase.

Insufficient data exist at present from which to make estimates of the carrying capacity of range for both tundra and taiga wintering populations of the Kaminuriak herd. Snow conditions limit the availability of terrestrial and arboreal forage in winter, and also restrict animals to specific habitats or sites. Both snow conditions and plant productivity will vary from year to year. In addition, high-quality summer range is required for the animals to attain sufficient fat reserves to enable the majority to undertake a long fall migration, for cows to conceive, and for the animals to enter the winter in good physical condition. Fat reserves of most animals are depleted during the winter. Poor physical condition of the cows may contribute to death of calves at, or shortly after, birth. Differences in calf survival may therefore be related to the amount of food available to pregnant females on winter range in relation to their energy expenditure, as well as to the quality of food on summer range.

Caribou are a traditional and important food resource to Inuit in the defined region, as well as to Indians in taiga wintering range. They are hunted in winter, at crossing places during migrations, and along the shores of lakes and in coastal areas during the summer.

Wolves are known to breed west of the defined region in Beverly Lake and the Thelon River area. They den, commonly, at tree line or in the taiga. The majority of wolves in the defined region seem to be non-breeders, which follow caribou herds from winter range in the taiga to summer range in the tundra. During winter in the taiga, caribou constitute the staple diet of wolves, and high wolf densities occur at times during maximum compression of caribou populations. In a study west of the defined region it was found that, while a greater variety of food was available to wolves in summer than in winter, caribou constituted the main prey species. However, lemmings and voles were important prey items regardless of the presence of caribou. Caribou calves were of principal significance to wolves that were near caribou calving grounds. While wolves are an important cause of calf mortality, other mortality factors may have equal or greater importance. Wolves and caribou have evolved together as components of biotic communities, and it is generally agreed that the impact of wolves on caribou populations is not well understood. Since increased requirements for food for increasing human populations in the North will undoubtedly be given as a prime reason for wolf control, the whole question of predator/prey relationships, as exemplified by barren ground caribou and wolves, requires further research.

Wolves are hunted by Chesterfield Inlet Inuit in the Daly Bay area and west towards Josephine Lake. Baker Lake Inuit also hunt wolves when trapping or when hunting caribou. Wolves are not considered to be very abundant in the region, although they are often found in the area of the lower Thelon River.

Arctic foxes occur throughout the defined region. Soil stability is essential for both wolf and fox dens, and the most frequently occupied dens are those on eskers or moraines overlooking broad valleys. Den site availability is not considered to be a limiting factor in the population size of arctic foxes, at least in the western part of the defined region. Survival of fox whelps appears to be closely related to both abundance of lemmings and time of occurrence of lemming reproduction. In summer, birds and eggs, fish, insects, berries, and caribou carrion are eaten, in addition to lemmings. In winter, lemmings remain an important food component, with carrion also frequently occurring in stomach contents. Foxes near the coast are known to scavenge in winter on seals killed by polar bears, and are attracted year round to camps and settlements where garbage is dumped. In the Chesterfield Inlet area, seal is used for fox-trap bait along the coast, but caribou kills are also used for trap bait inland. The relative proportion of foxes trapped on ice areas compared to inland areas is not known, nor is it known from where such foxes originate. Foxes are an important source of fur to trappers in the Baker Lake area. The most intensely trapped locations in the defined region are south of Baker Lake, from Andrews Lake through the Kazan River area to Thirty Mile Lake; the Parker-Banks lakes area; the St Clair Falls area; the Pitz Lake area; and the Thelon River area.

Two species of lemmings occur year round in the defined region. These are the brown and the collared lemming, which are found in all habitats except rocky eskers, river and lake edges, and sand dunes. However, the collared lemming is commonly found in well-drained lichen heath and heath-sedge hummock areas, while the brown lemming occupies lower and moister areas of sedge meadows and sedge hummocks. Lemmings are an important food source for resident as well as for migratory carnivores. Their populations may fluctuate markedly between years, and such fluctuations may be reflected in the abundance of arctic fox, weasel, and predatory birds in a given area. Winter breeding under the snow occurs in both species of lemmings in some years, and seems to be a prerequisite for peak populations. The wide fluctuations in population numbers that are characteristic of lemmings in all areas are not well understood.

Arctic ground squirrels are common near Chesterfield Inlet settlement and the offshore islands. They are active from the end of May through July. Their distribution is restricted to well-drained soil where deep snow accumulates in winter, so that burrows are well insulated during their long period of hibernation. Arctic hares occur along the coast and offshore islands, from west of Chesterfield Inlet southwest to Big Willow Bay. They are also found in the south channel area at the eastern end of Baker Lake and are hunted in these areas, as well as in the vicinity of both settlements. Like lemmings, arctic hares also fluctuate widely in numbers.

Ringed seals, bearded seals, harbour seals, and harp seals all occur in the defined region. Of these, ringed seals are the most abundant. Adults and some immature animals overwinter under land-fast ice by maintaining breathing holes. Immature seals are more generally found at the edge of land-fast ice, and young adults occur in areas of unstable land-fast ice. Reproductive females make birth lairs on the ice under snowdrifts that are formed around ice hummocks, or along rough pressure-ridge ice. These lairs are entered through breathing holes. Pups are born in April, and birth lairs may be located by scent by arctic foxes, which enter by digging through the snow. It is not known whether such predation is a significant factor in the defined region.

Seals bask in the sun on the ice near their breathing holes in the spring, during which time they both moult and fast. Reserves of blubber are depleted, which makes them less buoyant in the water. Coastal marine water may also provide less buoyancy during the period of inland ice breakup, when quantities of fresh river water are added to coastal areas. Ringed seals are an important food item to Inuit, and may be harpooned in winter at breathing holes, shot while basking on the ice in the spring, or shot in open water from boats in the summer. Ringed seals feed mainly on benthic crustaceans and zooplankton, in addition to such fish as polar cod. In some areas ringed seals may congregate in the fall in response to concentrations of fish, and in good weather they may then be hunted from boats. Hunting in the spring is relatively easy. However, because of reduced buoyancy and reduced salinity, many shot animals may sink and be lost to the hunter. Populations of ringed seals were formerly considered to be relatively stable and sedentary. However, recent studies have indicated that wide variations in reproductive success occur between years and that seals move over long distances. Estimates of numbers in Hudson Bay, of annual harvest, and of numbers killed by polar bear are at present only tentative.

Bearded seals (square flippers) are relatively common in the defined region, but less abundant than the smaller ringed seals. They feed almost entirely on benthic invertebrates, and are therefore found in relatively shallow waters of less than fifty fathoms. Populations may be limited by the accessibility of shallow, ice-free, feeding banks in winter. Like the ringed seals, they are relatively slow to reach maturity, but unlike the former appear to breed only in alternate years. Late maturation and low productivity mean that populations are slow to recover from disturbance or over-harvesting.

Harbour seals extend some distance into Chesterfield Inlet. They are associated with estuarine and freshwater conditions, and the extent of their dependence on marine habitat is not established. Harp seals occur in small numbers during the summer. They move into the area following ice breakup, and leave Hudson Bay before ice forms again.

Although walrus are common in the defined region, they do not appear to have been an important resource to Inuit from Chesterfield Inlet. They are not a ubiquitous species. The main stocks of walrus are found in northern Hudson Bay in the vicinity of Southampton Island, and northern Foxe Basin. Only small, widely scattered populations exist elsewhere in Hudson Bay and the eastern Arctic. Walrus are gregarious and are associated with pack ice and with shallow inshore areas free of land-fast ice during the winter. They feed mainly on benthic invertebrates, and are confined to depths between fifteen and eighteen metres. Where waters are shallow with gently shelving beaches, clams are common. When clams are not abundant, walrus prey on seals; and ringed seals are known to leave areas when walrus arrive. During the open water season, walrus concentrate on land at traditional sites. These are usually rocky islands or promontories which give quick access to deep water. Haul-out sites and inshore feeding areas are critical for the survival of walrus; however, there appears to be little information about such sites in the defined region. Because of low reproductive rates, critical sites for survival in winter and in summer, and the concentration of this species in one geographical area in the eastern Arctic, walrus are especially vulnerable to disturbance of their habitat and to overharvesting.

White whales (beluga) occur widely in the Arctic in summer. In 1975 their numbers were estimated at a minimum of 30,000, including about 10,000 animals in western Hudson Bay. They occur in the defined region and are believed to winter in Roes Welcome Sound, where leads of open water are common. They are coastal animals, capable of swimming in very shallow water. Mature females calve about once in three years, and river estuaries are used for calving. Large concentrations occur in warm estuarine waters during calving season, and whales are considered to be most vulnerable during this period. They feed on crustaceans, as well as on such fish as Greenland and polar cod and arctic char. In Hudson Bay they have no predators other than man. A commercial fishery at Churchill operated during a season of approximately six weeks, and in the 1950s and 1960s the catch was some 400 to 600 animals per year. The operation at Churchill proved only marginally economical. In 1961 a commercial fishery was started at Whale Cove, and meat and muktuk (dermis with subcutaneous fat) were frozen or canned, mainly for consumption in northern settlements. In 1970, mercury levels in excess of 0.5 parts per million wet weight were found in white whale meat. This level of mercury prohibited the sale of white whale meat for human consumption. However, mercury levels in muktuk were low. Fresh or frozen muktuk is rich in vitamin C and is a nutritionally rich food resource. Harvests of 500 to 1,000 animals in western Hudson Bay are considered permissible, on the basis of an estimated annual production of 1,400 young.

Bowhead whales were heavily hunted in the nineteenth century, and by the early twentieth century were almost totally depleted in northwestern Hudson Bay. They are presently found in low numbers from Chesterfield Inlet to Roes Welcome Sound. Populations are believed to be slowly recovering in the eastern Arctic.

Polar bears are not numerous in the defined region. They occur along the coast in the Daly Bay and Cape Fullerton areas. Seals are their major food source during the ice season. The fat and blubber of ringed seals are the preferred items, and meat is often left for scavengers. In summer a variety of food is eaten, depending on its availability. Seabirds and waterfowl with eggs and nestlings may be used extensively, or the diet may consist largely of plants. Some bears appear to eat very little during the summer and remain quite sedentary. Carrion may also be an important source of food and, like all bears, polar bears are notorious for their affinity to garbage dumps.

Young are born during the winter in dens which are excavated in deep snow banks on the leeward slopes of coastal hills or on the sides of pressure ridges. Pregnant females tend to concentrate in core areas in autumn. These areas may be defined by snow accumulation patterns which are favourable for denning. However, movement of pack ice driven by winds and tides may land bears in large numbers on coasts, such as the east coast of Southampton Island. The status of the defined region for den sites is not known.

(b) Some Current and Proposed Developments

Mining Exploration

In the District of Keewatin, mining exploration associated with aerial surveys and transportation started in a small way in the 1920s.[82] During the depression and war years exploration was minimal, but it increased during the last two and a half decades. Copper, lead, silver, and uranium have been found in the defined region. Uranium showings occur in the Kazan Falls and Christopher Island areas.[83] Ruzicka assessed some uranium occurrences and stated that basement rocks, the Kazan formation, and the Christopher Island volcanics have potential.[84] LeCheminant et al. described uranium-copper mineralization in sandstones and conglomerates in the Kazan River, Martell, Bissett, and Parker lakes region, and observed traces of molybdenite in the eastern part of Thirty Mile Lake and Kazan Falls area.[85] Prospecting permits and claims held for 1976 in the defined region are shown in Figure 7.

Increased intensity of exploration has involved the

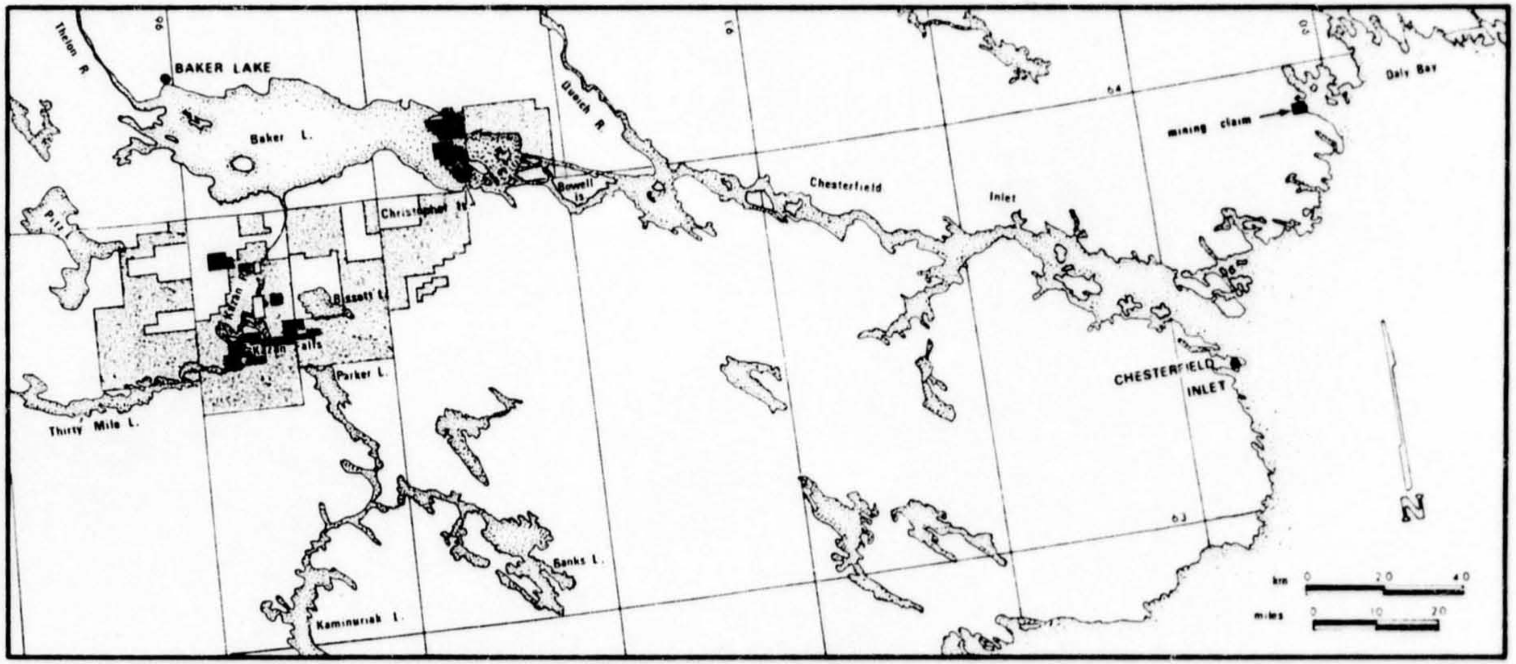


Figure 7 Mining Interests in Baker Lake–Chesterfield Inlet Region

Prospecting permits (shaded areas) and mining claims (black areas) held in 1976.

emergence of large competitive companies using sophisticated techniques and high levels of logistic support. In April 1974 Inuit from Baker Lake stated their concern about the effects of large-scale exploration on the land and water and on wildlife. Activities which gave rise to concern included blasting, aircraft flying at low levels in the course of surveys, and increased air traffic to provide logistic support to various base camps located in areas of importance for wildlife. Such disturbance was reported to have affected wildlife in the Kazan Falls and Christopher Island areas. It was feared that plans for mineral exploration for lead, zinc, and copper on Christopher Island would adversely affect the fox population in that area.[86] In addition, Inuit hunters reported that caribou migration patterns had already been affected by exploration activity at Kazan Falls. Pan Ocean Oil Ltd. had a base camp at Kazan Falls. Cominco Ltd. notified the Baker Lake Council that it intended to use thirty men and two turbine helicopters to conduct ground and aerial surveys and diamond drilling operations from a base camp six miles southeast of Kazan Falls.[87] In June 1974 Inuit of the Baker Lake area requested that the then Minister of Indian Affairs and Northern Development, Jean Chrétien, declare the area a Land Management Zone where Territorial Land Use Regulations would be enforced, and that full consultation with settlement councils be undertaken in the case of applications for exploration permits. Although Mr Chrétien promised that this would be done by 1 January 1975, this commitment was not met.[88] A telegram was then sent to the new Minister of Indian Affairs and Northern Development, Judd Buchanan. Mr Buchanan replied that revisions to the TLUR were being prepared, allowing classification of the area as a Land Management Zone, but that the preparation would take some months. In view of the exploration activities that were planned for the summer of 1975, the Baker Lake Settlement Council stated that such a delay was unacceptable and requested through the Inuit Tapirisat of Canada that a land freeze be obtained for five zones in the Baker Lake area. The reasons for the proposal were well documented by a map which defined critical areas for wildlife and some areas of cultural significance. Mr Buchanan refused the request.[89]

In the defined area, the following exploration was undertaken during 1975: Pan Ocean Oil Ltd. added eight new prospecting permits to its existing one, south of Baker Lake. Its base camp remained at Kazan Falls. Uranerz explored north and west of Baker Lake. Rio Alto Exploration was based at Baker Lake. The Geological Survey of Canada surveyed in the Thirty Mile and McQuoid Lake areas.[90] Cominco Ltd. set aside $700,000 for drilling, surface sampling, and geological and geophysical surveys, in connection with a significant uranium prospect near Baker Lake that involved more than 2,300 square miles.[91] Shilts noted that over 100 people were engaged in uranium and base metal exploration in the general area, during the summer of 1975,[92] at which time the District of Keewatin was still not classified as a Land Management Zone and was therefore not subject to the TLUR. However, the Northwest Territories Division of Game Management requested mining companies to advise their pilots to observe a minimum altitude of 1,500 feet over caribou calving and post-calving areas from 25 May to 20 June. In the 1976 season Cominco planned to resume activity in the Baker Lake area, where the best discoveries from diamond drilling have revealed a mineralized zone at 113 metres averaging 2.6 pounds of uranium oxide per ton.[93] Cominco's programme involved twenty-five to thirty men in a camp located south and then west of the Kazan River. Exploration activities included surveying and diamond drilling on permits formerly held by Pan Ocean Oil Ltd. in an area south and southwest of Baker Lake, with twenty holes to be drilled northwest of Bissett Lake.[94] In the defined region surveys were also planned for the 1976 season in the Pitz Lake area and the southeastern part of Baker Lake.[95] Baker Lake settlement was the centre of logistic support for other exploration activities in the region.

Under the revisions to the TLUR, all lands in the territories became Land Management Zones on 4 March 1977. At that time the Minister of DIAND, Warren Allmand, under Section 25 of the revised TLUR, deferred a decision for one year on applications for five new prospecting permits and four new land use permits in the Baker Lake area. The decision was deferred on the grounds of concern for the possible effects of increasing levels of exploration activity on wildlife that are of importance to Inuit of Baker Lake. A contract for an environmental impact study was granted in June 1977, the results of which were to be available to Mr Allmand before March 1978. Mr Allmand's action was interpreted by the mining industry and the media as a "land freeze." However, existing permits are not affected, and exploration activity can continue. Section 25 is a revision of Section 20.1.C, which allowed deferral for six months of a decision on an application permit.

Seismic Exploration and Offshore Drilling

Pimlott et al. documented the history of oil exploration in Hudson Bay, including two unsuccessful offshore drilling attempts made in 1969 and 1974.[96] In 1975 a total of 625 exploratory permits, involving thirty-eight million acres, were held in Hudson Bay. By January 1976 ninety-six permits involving nearly six million acres had been terminated,[97] and acreage under permit subsequently continued to decline.[98] The permits closest to the defined region are located off Cape Kendall of Southampton Island at the entrance to Roes Welcome Sound. On 29 April 1974 the people of Chesterfield Inlet publicly stated that they were opposed to any offshore drilling or seismic activity in Hudson Bay. Their reasons were that such activity would greatly affect marine animals and that oil spillage or leakage could damage large areas many miles distant from the source of spill, due to movements of currents in the bay. While acreage under permit in Hudson Bay has declined each year since 1968, future plans are uncertain. Permits are under the jurisdiction of the Department of Energy, Mines, and Resources, and exploration activity does not appear to be subject to the Environmental Assessment and Review Process, nor to any other form of social or environmental review.

Transportation of Gas

In November 1972 the Polar Gas consortium was formed, comprising Trans-Canada PipeLines Ltd., Panarctic Oils Ltd., Tenneco Oil of Canada Ltd., Pacific Lighting Gas Development Company, the Ontario Energy Corporation, and Petro-Canada Ltd. The consortium was formed to investigate the feasibility of a natural gas pipeline or other modes of transmission to transport natural gas from the Arctic Islands to southern markets. A pipeline was found to offer the most economical means of transportation. In May 1977 reserves from the gas fields were stated to be 12.8 trillion cubic feet.[99] In order to make such a project economically feasible, reserves of about 20 trillion cubic feet are required, with a minimum throughput of 2 to 3 billion cubic feet per day, increasing to an ultimate of 3.5 to 4.5 billion cubic feet per day. Such a rate of flow would require a pipe diameter of forty-two to forty-eight inches over land routes and up to thirty-six inches for marine crossings.[100] At present, the suggested route for the pipeline crosses the defined region west of Baker Lake. No formal proposal has been submitted to date. However, a proposal is expected to be submitted by early 1978. Review of the project may be undertaken through the Environmental Assessment and Review Process, which would require Polar Gas to submit an Environmental Impact Statement according to guidelines drafted by the Department of Fisheries and Environment. Alternatively, Mr Allmand indicated that he would consider a "Berger type" inquiry.[101] Environmental studies by the Department of Fisheries and Environment have been in progress along much of the suggested pipeline corridor since 1975. Lamoureux summarized preliminary environmental research undertaken by Polar Gas, and research is to continue through 1977.[102]

Marine Transportation

In 1972 a proposal for a deep-water, year-round port located at Chesterfield Inlet was made to Prime Minister Trudeau by Richard Rohmer and Captain T.C. Pullen, as members of the Great Plains Project.[103] The site for the proposed port, to be called "Northport," has protected water to a depth of 30.5 metres. This depth would accommodate vessels in the range of 150,000 tons. Rohmer stated that there would be no problem from wind-piled ice, since the location would be protected from northerly winds. The plans included a "climate-controlled community" for operation of port facilities, and stated that tertiary-treated, potable, heated effluent together with aeration would keep the port ice-free during the winter. Specially designed ice-strengthened cargo ships were proposed to operate between the Arctic Islands and the port, assisted by the Canadian ice-breaker fleet. It was suggested that "Northport" would have transportation links to the north, east, and south. A railway and possibly a highway and pipeline "laid out on eskers" were proposed to link "Northport" to Churchill. The fact that the eskers in the vicinity run northwest instead of south/southwest appears to have been overlooked. Material quarried from eskers may provide fill, but a railway from Chesterfield to Churchill cannot be "laid out on eskers."

Hydro-electric Power

The hydro-electric power potential of the Thelon, Hanbury, Dubawnt, and lower Kazan rivers was investigated by Ingledow and Associates Ltd. for the Department of Indian Affairs and Northern Development.[104] Compared to flow patterns of the Kazan River, those of the Dubawnt River were found to be more profoundly affected by the greater lake storage capacity of the Dubawnt River basin. High winter flows were maintained in the Dubawnt, and peak summer flows from storms were drastically reduced in comparison with those of the Kazan River. The run-off volumes of the Kazan River were found to be twenty-five to thirty percent higher than those of the Dubawnt River. However, only three years of data were available. Potential dam sites for the Kazan River are at the outlet of Thirty Mile Lake, at

Kazan Falls, and ten miles upstream from Baker Lake. There have been no environmental impact studies of the effects of the development of hydro power on any of the rivers studied.

Pressure for development of the hydro-electric potential of the Kazan River may arise from increased needs for energy in the settlement of Baker Lake. The possibility of electrification of any Polar Gas pipeline would also increase the pressure for development of hydro-electric capacity. However, it is likely that the most immediate pressure for hydro-electric power from the Kazan River would be the development of any uranium project in the area. The value of uranium is high compared to that of base metals. Since uranium can be shipped out by air, development of a mine is not dependent upon the construction of a road or railway.

Territorial Administration Centre

In February 1976 an Inuit Land Claims proposal was presented to the federal government. The proposal involved the creation of a territory – Nunavut – which would be governed by a commissioner and an elected council. The settlement of Baker Lake was suggested as a possible candidate for the administration capital of Nunavut.[105] If such a development were to take place, there would follow an increase in both the resident and transient population and an enlargement of the settlement, with increased facilities for transportation, communication, and accommodation. A long-term source of energy would be required to meet such a development. This might be supplied by hydro-electric development or on a short-term basis by gas, if a Polar Gas pipeline is constructed in the area. Although it has not been suggested, windpower is a possible long-term source for at least part of the energy requirements. The average annual windspeed recorded at Baker Lake is 14.3 miles per hour. Speed and percent frequency are greatest during the winter months, when energy requirements are also greatest.

Parks and Other Reserves

Part of the defined region was also proposed as an IBP-CT site.[106] The site includes known calving areas, as well as much of the area that is known to be used by post-calving concentrations of the Kaminuriak barren ground caribou population (Figure 6). The vegetation is considered representative of mainland tundra, with sedge meadows and tussock muskeg occurring in low-lying, poorly drained areas, and with lichen-heath communities in drier uplands. The site also includes the Kazan Falls and lower Kazan River and the south shore of much of Baker Lake. The proposed site has yet to be formally submitted for approval, and at present has no legal protection.

(c) Potential Resource Use Conflicts

Bedrock outcrops occur throughout much of the defined region. Wherever such outcroppings form areas that preclude easy access to mammalian predators, they have potential for nesting birds such as falcons, colonies of seabirds and, at Kazan Falls, snow geese. In addition to providing cliff nesting sites for seabirds, coastal and island rock may also provide hauling out areas for walrus, if such areas are associated with relatively deep waters allowing rapid escape. These areas are critical for the survival of walrus, and disturbance on or near such sites would be incompatible with the maintenance of walrus populations. Soapstone occurs on Christopher Island and is used by Inuit from Baker Lake. Bedrock may be used in many different kinds of construction. Dam construction on the Kazan River at any of the three proposed sites would require quarried bedrock.[107] Mining companies blast and drill in bedrock, while the development of mines requires intensive disturbance and removal. As far as is known, potential for conflict lies less in the use of bedrock in this region, than in the locations where construction or disturbance takes place.

Both wolves and foxes require stable areas of well-drained sandy soil for their dens. In a permafrost region where up to twenty-three percent of the terrain is covered by water, and much of the remaining vegetated area is low-lying and poorly drained with a shallow active layer, features such as eskers are of importance for den sites. Similarly, raised beaches afford burrow sites for collared lemmings. During snowmelt, when lowlands are flooded, both brown and collared lemmings are concentrated on these raised beaches. At this season both eskers and raised beaches also afford good travelling conditions for man and caribou, and the slopes, according to their aspect, provide early growing forage for herbivores. During spring breakup eskers and raised beaches are commonly used as landing strips by small aircraft, until the lakes become ice-free and floats can be used. Ingledow and Associates suggested that an esker southeast of the Kazan Falls dam site would provide a good source of sand for mining which, with river gravel or crushed bedrock, would make suitable concrete aggregate.[108] Construction of a railway, an all-weather road, or a pipeline would have potential for conflict either by habitat destruction or by competition for space on well-drained land surfaces.

Wet sedge meadows are areas of high plant productivity and of critical importance to caribou and Canada geese for accumulating the reserves of energy required before fall migration. Toxic chemicals, salt water used in exploratory drilling, and waste materials transported by water may accumulate in such low-lying areas, if these wastes are not transported by defined drainage systems through streams and rivers to lakes. The proposed Polar Gas pipeline route crosses wetlands west of Baker Lake which are important for nesting waterfowl and peregrine falcon, and have been defined as part of a caribou migration route. Wetlands north of Thirty Mile Lake which are crossed by the proposed Polar Gas pipeline may also be of importance to the Beverly caribou herd or part of the Kaminuriak herd. Significant drainage alterations could occur in the wetlands west of Baker Lake (Sugarloaf Mountain), together with disturbance in organic terrain and unstable colluvial areas. If the water tables of the wetlands are changed, there would be significant changes in vegetation which would reduce the productivity of the areas for waterfowl and caribou.

The Kazan and Quoich rivers, in contrast to much of the Thelon River, do not have well-developed valleys and are consequently not as important to wildlife during winter as many other northern rivers. However, like the Thelon River, they are important for fish and waterbirds. Inuit have stressed the importance of river and stream mouths for fishing, as well as Pitz Lake and parts of Baker Lake.[109] In summer, major tundra rivers still form routes of travel navigable by canoes, and the Thelon River is a traditionally important route. Proposed hydro-electric development on the Kazan River would have various effects, according to the location of the dam. If sited on the lower Kazan, water would be backed up over Kazan Falls.[110] Proposed dam sites for the Thelon and Dubawnt rivers are outside the defined region, but such dams would have downstream effects. The potential for conflict with the maintenance of fish and bird populations would be high. Most of the impact studies of hydro development have been related to fish. Nevertheless, from a review of the literature, including Russian and Scandinavian sources, Machniak concluded that there was insufficient knowledge of effects on fish and that it was an area of research that required urgent attention.[111] The impact of hydro-electric developments in Canadian Shield tundra regions of continuous permafrost is not known, and information about the impact in other arctic regions is minimal.

The proposed Polar Gas pipeline route both crosses and follows part of the Thelon River. The route along the valley will conflict with caribou range used in August and September, and with peregrine falcon nesting habitat. Unstable colluvial areas may present problems in a crossing of the Thelon River and increase the potential for siltation. The proximity of the pipeline to Pitz Lake, and the necessity of many crossings of streams flowing into this lake, will conflict with the use of the lake and river mouths as an important domestic fishing area for trout, whitefish, and grayling. Newbury outlined major hydrologic concerns associated with the construction of a Polar Gas pipeline as follows: bank instability of valleys and major rivers; streambed instability; upland erosion and drainage; disposal of spoil materials, waste materials, and toxic substances; and use of water supplies during construction practices.[112] One feature relating to water supplies is the necessity of creating artificial snow for snow roads. Since snowfall in the defined region is light, and many lakes and streams are shallow and freeze solid, lakes and rivers that are deep enough from which to take water are also likely to be those which are most important for overwintering fish.

Tundra nesting birds are especially susceptible to predation, since most vegetational cover is low and sometimes sparse. Small islands offer protection against mammalian predators and, where distant from navigable waters, offer protection against human predators. There is some evidence that population fluctuations of lemmings may not be as severe on some islands, such as in Baker Lake, as on the mainland.[113] Islands may therefore form reservoirs from which recolonization of depleted areas may occur.

Chesterfield Inlet and adjacent coastal waters are relatively rich in marine and estuarine wildlife. Irregular coastline, tidal flats, islands and reefs, together with mixing of waters of different salinities and temperatures, provide a diversity of conditions favourable for several species of marine mammals, waterfowl, and seabirds in summer. In winter and spring, large areas of stable land-fast ice separated from pack ice by wide leads, and the proximity of Roes Welcome Sound, provide good wintering habitat for ringed seals and common eider. Probably the greatest source of conflict is seismic exploration involving blasting and wildcat drilling, together with the transportation of oil. The effects of blasting on the physiology and behaviour of marine mammals is not known, although some effects on fish have been documented.[114] The hazards of oil spills from blowouts, leakage from wells, or leakage during oil transport, and the lack of technology for clean-up in northern waters were documented in 1976 by Pimlott et al.[115]

If increased shipping is required for transportation of materials to Baker Lake, it may be necessary to dredge in Chesterfield Inlet and the south channel past Bowell Island in order to accommodate larger ships. It is also possible that the rock sill at the entrance to Baker Lake would have to be blasted. If the present tonnage of ships is maintained, there would need to be an increase in the number of ships to handle sufficient freight during the very short season.

The effects of increased levels of human activity are probably the most difficult to predict, since different animals respond in different ways, and thresholds of tolerance vary according to seasonal activity and other forms of stress. Stress is also difficult to measure. There may be no obvious behavioural response, but metabolic levels may be increased at a time when energy expenditure needs to be conserved. Disturbance from increased human activity is probably the most insidious and also the most difficult form of disturbance to control. Although aircraft may be required to fly at a certain minimum height, bad weather may force them to fly at lower altitudes. The location of camps is sometimes restricted to certain areas for logistic reasons and, when the camps are maintained by helicopter transport, noise levels in such localities may be very high. In addition to logistic support, most forms of surveying or monitoring in the Arctic require intensive use of aircraft. Biological and geological activities, as well as those associated with construction and mining exploration, reach a peak in the short summer season when terrestrial animals need to replenish depleted fat reserves. Movement of these animals away from areas of high human activity may mean movement to areas that are less productive in food. The migratory routes of caribou and traditional river crossings are areas where the potential for conflict is high, even though these areas may not be used in all years.

IV The Pelly-Macmillan Rivers Region

(a) Description of the Area

The Pelly-Macmillan river system is an important headwater tributary of the Yukon River. The confluence of the Pelly and Macmillan rivers lies in the south-central part of the Yukon Territory (Figure 8). The area, subsequently called the defined region, includes the Macmillan and Kalzas ranges to the north and part of the Glenlyon Range to the southeast. It is crossed by a major geological fault, called the Tintina Trench, which extends from the southern part of the Pelly Mountains in the southern Yukon, northwest into Alaska.

The defined region lies within the subarctic climatic zone. Mean annual precipitation is between twenty-seven and thirty centimetres, with maximum precipitation occurring in July. Snowfall is heaviest during November and December. However, due to the influence of mountain ranges there is considerable local variation. The defined region is within the zone of widespread but discontinuous permafrost. Silts and clays of glaciolacustrine origin occur along the Pelly River above the mouth of the Macmillan, and along the Macmillan River. These deposits are unstable when saturated, and there is considerable slumping of the river banks. Massive slides have been known to dam the Macmillan River for brief periods, and large driftwood piles at the heads of islands are common. Nineteen kilometres below the mouth of the Macmillan, the Pelly River passes through Granite Canyon, forming a stretch of navigable rapids. Coal deposits occur in the Granite Canyon area. Ice breakup on the Pelly River at the settlement of Pelly Crossing occurs about the middle of May. Discharge of water peaks during June, and silt loads are fairly high. Permanent ice is formed early in November. During winter, water levels are extremely low. Although some open water areas have been observed on both the Pelly and Macmillan rivers, indicating ground water discharge, as yet none have been located in the defined region.

Unless detailed studies of a particular stretch of river have been undertaken, it is not possible to limit a description of fish resources to such an area. Even where such data are available, description is limited to a region only for the sake of brevity, and it is implicitly assumed that one must think in terms of the entire river system. Most of the subsequent data relating to fish were obtained from studies of the upper reaches of the Pelly and Macmillan rivers and associated lakes, and from the Yukon River. The fish resources are consequently described in relation to the river system. Even so, distribution of fish species within the Pelly-Macmillan system has not been well documented, and there is a paucity of information pertaining specifically to non-anadromous fish. For this and other reasons, the emphasis in the following description will be on salmon. Salmon have not been mentioned before in this report. They are of international importance because they migrate through the Yukon and Alaska, and become a component of the fish resources of the Pacific Ocean; they are highly vulnerable to development-related disturbance; their populations have declined in other parts of the country; and they are of major importance in terms of food, both for humans and as part of a food chain

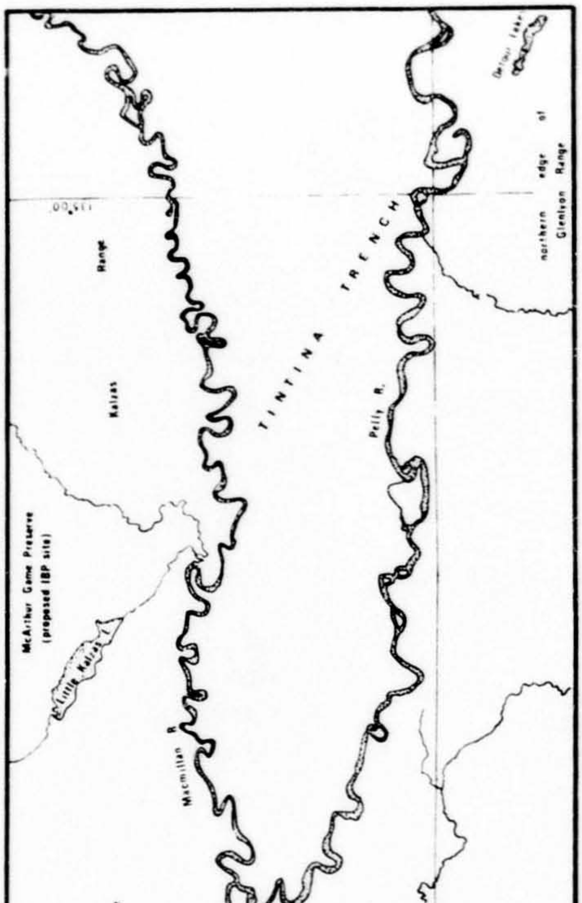


Figure 8 Pelly–Macmillan Rivers Region

in which they tend to reverse the general flow of nutrients to the sea, without benefit of human intervention.

Chinook salmon are the largest of Pacific salmons. They spend four to six years at sea, and return to their natal streams to spawn. The spawning of chinook salmon in the Pelly-Macmillan system involves one of the longest migrations of an anadromous population, with some individuals travelling over 1,950 kilometres to reach their spawning grounds. Migrating chinooks appear at Dawson during the first week in July, and the run peaks in late July and early August. The number of chinook salmon passing Dawson has been estimated at between 29,000 and 36,700. Since this species exhibits a four-year cycle in abundance, the population estimates from different years would be expected to vary. The above estimates are probably low, since large salmon tend to travel in deeper water in mid-channel, and are not often captured with shore-based fishing gear. The first mature chinook salmon enter the Pelly River from the Yukon River around 10 July. Salmon which travel long distances to spawn are often critically emaciated by the time they reach their natal stream. Such fish have little reserve energy to cope with new barriers in the path to their spawning area. Delays in migration, of as little as twenty-four hours, can result in drastic declines in egg production if fish are nearly ripe at the time of delay.

Populations from different river systems probably have unique, genetically determined traits which are suited for coping with the conditions in their natal system. As long as the environmental variations are well within the tolerance limits of the specific population of salmon, the rates of reproduction and survival remain high enough to maintain the population. If conditions are altered sufficiently, the salmon population of a river system will begin to decline. Loss of populations of salmon from a whole river system is serious; because the population may have been a unique genetic race, it is extremely difficult to repopulate the system with different genetic stocks. Headwater races of salmon, as compared with other races from lower parts of the same river system, tend to have a very limited tolerance of environmental variations. A narrow tolerance range would therefore be expected for the salmon populations of the Pelly-Macmillan system, which is a headwater area.

Chinook salmon spawn in water from 1.2 to 2.4 metres in depth, where the substrate consists of clean gravels. The outlet streams of lakes, areas with islands and braided channels, backwater areas, and areas with groundwater flow are preferred spawning areas. The eggs remain in the gravel of the stream bed through the winter months. They cannot survive where there is heavy siltation or in the absence of well-oxygenated water. Areas of groundwater inflow which remain open all winter, deep pools, and the outlets of lakes all seem to have sufficient water flow through the winter to ensure the survival of the developing eggs. Fall spawning, under natural conditions, usually ensures that eggs will be developing in the gravel at a time when the silt load of the river is at its lowest level.

Chinook salmon fry emerge from the gravel in May. Because feeding is mainly by sight, it is important that nursery streams have reasonably clear water and high densities of food organisms. Since small streams have these characteristics, young salmon often move to these areas immediately after breakup of ice in the spring. Hence the small streams, although inadequate for spawning and overwintering, are indispensable as nursery areas for young salmon during the summer months. With the onset of autumn, the young salmon are forced to return to areas where water flow continues throughout the winter. One or two years after hatching, the young chinooks begin their migration to the ocean.

There are no published estimates of the total spawning population of chinook salmon using the Pelly-Macmillan system. However, there are fifty-one known spawning streams above Dawson, over thirty-three percent of which occur in the Pelly-Macmillan system. The Pelly-Macmillan system appears to rate as one of the most important chinook salmon spawning areas above Dawson. An important point to consider is the fact that the spawning population of the upper Yukon River, above Whitehorse, has been steadily declining since 1959, when the Whitehorse Rapids Dam was installed. If this trend in the upper Yukon River continues, then the Pelly-Macmillan system will become even more important in maintaining the salmon stocks above Dawson.

Chum (dog) salmon from the Yukon River drainage spend three to five years at sea before returning to freshwater to spawn. The spawning distribution of chum salmon in the Yukon system is not as well known as that for chinook salmon. Since adult chum salmon rarely attempt to negotiate barriers of any size, it is likely that these fish are more limited in distribution than chinook salmon of the Yukon River system. The chum salmon run in the Yukon River begins about five weeks later than that of chinook. The first chum salmon arrive at the mouth of the Pelly River around August 30. They travel up the Pelly to the level of Faro, and up the Macmillan to the level of Russell Creek. The spawning areas of chums are usually in shallower water than those used by chinooks, but in other respects the spawning requirements are similar. One known spawning area exists on the Macmillan River directly south of Moose Lake. No estimates are available for the number of chum salmon spawning in the Pelly-Macmillan system. Chum fry emerge from the gravel in May, but unlike the fry of chinooks, they begin to migrate downstream almost immediately. Most chum salmon fry are gone from the Pelly-Macmillan system by mid-July. The period of downstream migration coincides with high water levels in the river system, which ensure that the descent to the ocean occurs as rapidly as possible. The fry are adapted to spending a limited time in freshwater, and any major delay in downstream migration might significantly reduce their survival.

In addition to its value as one of the major spawning areas for chinook and chum salmon, the Pelly-Macmillan system supports large populations of arctic grayling, round whitefish, broad whitefish, inconnu, longnose suckers, and northern pike. It is probable that there are also migrating populations of these species which inhabit the system for only part of the year. The lakes of the Pelly-Macmillan region contain resident populations of lake trout, lake whitefish, round whitefish, northern pike, and burbot. Most of the system is still in its natural state; its tributaries are important spawning and nursery areas for resident and migratory fish populations, and it probably plays a major role in maintaining the fish populations of the upper Yukon system.

The historical importance of Indian fisheries within the Pelly-Macmillan system is well documented by written and oral records. The availability of salmon as a dependable food source played an important role in determining the group size and social order of Indian bands, and allowed higher summer populations of Indians in this region than in areas in the Yukon Territory which did not have salmon. At present the Pelly-Macmillan system is the second most important salmon fishing river of the Yukon system, after the Yukon River itself. Salmon add a substantial amount to the subsistence economy of Indians at Pelly Crossing and Ross River. In addition they are of importance to trappers who maintain dog teams. Broad whitefish, inconnu, lake whitefish, northern pike, round whitefish, lake trout, and longnose suckers are also obtained at domestic fisheries. In winter, whitefish, trout, and pike are caught in lakes near Ross River; and nets set under the ice at Pelly Crossing have in the past yielded large numbers of broad whitefish. The Pelly-Macmillan region supports seven percent of sport fishing in the Yukon, and there is potential for increase in this use. Arctic grayling, inconnu, and northern pike are the most important sport fish.

The valleys of the Pelly and Macmillan rivers are forested, with good stands of white spruce on better drained areas within the flood plains and on benchlands. Black spruce occurs on wetter sites, and typically in areas of muskeg. Aspen poplar stands and open areas of grasses and forbs are common on south- and west-facing slopes and on benchlands above the rivers. Mixed stands of spruce, paper birch, balsam poplar, and shrubs also occur along the river valleys. Although much of the defined region is well forested, the river valleys are not as productive, in terms of timber potential, as those of the Liard, Peace, and lower Mackenzie rivers. However, like most alluvial soils, they are productive in terms of vegetation and wildlife and, as evidenced by trappers' home sites, garden produce.

Above the mouth of the Macmillan, the Pelly River is characterized by large sandbars which are used for staging by sandhill cranes. Large flocks of these birds migrate to nesting grounds in Alaska and Siberia. Although reported to use the Tintina Trench flyway, flocks are also observed to stage annually near the mouth of the Pelly River. The relative importance of the Tintina Trench flyway is not known. However, numerous waterbirds, including trumpeter swans, Canada geese, diving and surface ducks migrate through the defined region. The presence of Pacific and common loons and kingfishers in Little Kalzas Lake attests to the productivity of the lake for fish. Parts of the defined region are used extensively for nesting by ducks and shorebirds. Oxbows, sloughs, and sedge meadows provide abundant food and cover for fall staging and for nesting waterfowl and shorebirds. These areas are also productive for muskrat and mink. Silt bars along the rivers have extensive areas of horsetail, which are closely grazed by Canada geese in late summer and early fall. Riparian communities are maintained in different stages of development by the regime of the rivers. Annual flooding, undercutting, redeposition of sediments, and changing channels produce diverse and productive plant communities. Beaver are relatively common in parts of the defined region, and along the rivers they use areas of slack current to anchor feed-rafts and build bank dens where the soil is stable and poplar and willow are abundant. Below the mouth of the Macmillan River, colonies of cliff-nesting swallows are numerous on south-facing and stable cutbanks. Spruce and ruffed grouse occur at lower elevations, and willow and white-tailed ptarmigan are abundant at higher elevations in the McArthur Range, and presumably also in other ranges within the defined region.

In addition to beaver, muskrat, and mink, fur-bearers that are trapped in the defined region include black bear, wolf, coyote, lynx, marten, wolverine, otter, weasel, squirrel, and red and cross fox. The mosaic of plant communities within the region provides diverse habitats which are important to different species at different seasons. South- and west-facing slopes of grassland become free of snow early in the year, and plant growth accordingly begins early. The legume *Hedysarum* is a component of this community, and is an important food source to black bears in the spring. *Hedysarum* also grows on floodplains and, together with other legumes growing on gravelly sites, is sought by grizzly bears, which occur in the defined region. Horsetail forms abundant ground cover under spruce, as well as on silt bars, and is also an important food for bears in the spring. In late summer, the river valleys and upland communities produce an abundance of berries that are used extensively by bears (and occasionally by man). Salmon spawning areas are important to black and grizzly bears as well as to bald eagles.

The movement of animals between different altitudes is governed to a large extent by weather, snow conditions, and seasonal variation in the availability of food and cover. In this respect the defined region is of particular importance to moose. In 1971 large burns occurred on both sides of the Pelly River in the vicinity of Granite Canyon, and in 1969 between the Pelly and Macmillan rivers, south of the Kalzas Range. There are also older burn sites within the defined region where regeneration has provided abundant food for moose. In the uplands such areas are important for moose in summer. However, moose generally overwinter in river valleys, and both the Macmillan and Pelly rivers are important overwintering areas. Unlike some other areas in the Yukon, the Macmillan River is also important for breeding. Twinning in northern populations of moose is not common, and therefore the percentage of a population that can be taken by hunters must remain lower than that in the South. However, moose are an important food source in the subsistence economy of such Indian, Metis, and white persons in the area whose way of life is bound to the land. With high prices for imported meat, moose and other game animals are hunted for food by urban residents as well as for recreation associated with hunting. Caribou, historically abundant during some years, are now uncommon in the defined region. Small populations of Stone sheep (thinhorns) are resident in some ranges, and these, together with grizzly bear and moose, are an important resource to big game outfitters.

Use of the land and wildlife resources has changed according to historical events. Because of seasonal differences in concentrations and movements of different wildlife species, large areas of land were originally required to support a subsistence economy. A traditional Indian gathering place was located at the outlet of Earn Lake just outside the defined region. The remains of a village and a graveyard are situated near the mouth of the Little Kalzas River. The fur trade changed the pattern of land use to some extent. However, highway construction ensured the establishment of permanent settlements along such routes. The Indians of Fort Selkirk were moved to Pelly Crossing with the completion of the Klondike Highway in 1952.

(b) Some Current and Proposed Developments

Hydro-electric Power

Since the early 1950s the Northern Canada Power Commission, a federal Crown corporation, has been involved in the assessment and development of hydro-electric resources in the Yukon Territory. Numerous inventories of potential hydro power sites have been conducted by NCPC since its formation. These inventories were partly a result of rising energy consumption in the Yukon Territory itself, but largely pertained to the sale of power outside the Yukon.[116] The previous studies had not provided a comprehensive inventory of the Yukon's power resources, nor did they rank the potential power developments relative to the total power needs of the Yukon.[117]

To achieve these goals NCPC commissioned Sigma Resource Consultants Ltd. to conduct a detailed study of the hydro power resources of the Yukon. The objectives of the study were to estimate future electrical load demands in the Yukon to the year 1990, to conduct an inventory of available energy resources, and to select the most promising of the alternatives. Load projections were calculated for the period 1975-90, with several contingency plans outlined. The single most critical factor in the load projection was whether or not a lead-zinc smelter would be built in the Yukon before 1990. Several alternative cases for load projections were outlined. The first case assumed that no smelter would be built and predicted a 1990 peak electrical demand of 106 to 202 megawatts, with a standard demand of 143 megawatts. The second case assumed a smelter would be built, and predicted a 1990 peak electrical demand of 218 to 302 megawatts with a standard demand of 243 megawatts.[118] Sigma stated that these projections were subject to a large degree of uncertainty, but that the standard load projections were the best guess of future loads at that time.[119] The two main cases were also subdivided into several subcases, with revised projections being based on contingencies such as population growth, fuel prices, electrical spaceheating use, and mining activity. Other industrial loads were also predicted, including power-intensive industries such as aluminum smelting, which might be attracted to the Yukon due to the area's hydro-electric power potential. Such a possibility was suggested even though it is stated NCPC policy to meet power demands as they arise, but not to create a demand.

A brief inventory of alternative power sources was conducted, and all types of power resources except hydro-electric were rejected on the grounds of being unfeasible or unproven. No clear comparison of hydro-electric and thermal power plants was conducted, due to a vague knowledge of fuel costs. No effort was made to assess the potential coal reserves of the Yukon, and a literature review on the subject was apparently not conducted. Sigma did note that, in the low size range of power plants (30 to 50 megawatts), thermal electric plants may be competitive with hydro-electric installations on the basis of the cost of power produced.[120] The remainder of the report largely consisted of an analysis of the potential hydro-electric sites.

Approximately one hundred potential hydro-electric sites, each having 30 megawatts or more of installed capacity, were identified. The sites included in the inventory are probably technically feasible, but no sub-surface exploration was conducted to prove their feasibility.[121] The Pelly River system was assessed as having five potential dam sites: at Braden's Canyon, Granite Canyon, Detour Canyon, Ross Canyon, and Hoole Canyon. All of the hundred identified sites were then ranked according to their potential for development. Primary sites were classed as level one. Their selection was based on geographical location and investment costs, but with no environmental or social factors taken into consideration. Two of the Pelly River sites – Hoole Canyon and Granite Canyon – were designated as level one sites, of which there were a total of ten. Level two sites were those which would provide cheap power if the corresponding upstream sites were built. Investment cost and location were again the important criteria. The Braden's Canyon site on the Pelly River was included in this category. Level three sites were those with good potential for development in the future. The Detour Canyon site on the Pelly River was included in this category. Level four sites were those that had been described by previous studies as having potential. The Ross Canyon site on the Ross River was included in this category.[122] All of these sites were designated as having potential on the basis of their geographic location and investment costs, with the provision that, for level two sites, the corresponding upstream sites be built. No environmental, socio-economic, or alternative resource use considerations were incorporated into the study at this stage. The preliminary group of one hundred sites was then reduced to a total of sixteen, prohibitively high energy costs being the basis upon which most of the projects were excluded from furthur studies.[123]

Detailed examination of the remaining selected sites was then conducted. For the sites on the Pelly River, several new alternatives were incorporated for the additional studies. In the level one group, both a high and low dam were considered for the Granite Canyon site. In the level two group, the Braden's Canyon site was re-examined in relation to high and low dams at Granite Canyon. Stephens and Strang suggested that Granite Canyon was the key site on the Pelly and that the Braden's Canyon site would only be economical if the former dam were built.[124] This detailed examination and ranking of sites was used to determine which sites appeared most promising on the basis of investment cost (including reservoir clearing at $600 per acre), location, and installed capacity. As in the previous ranking, environmental and social costs were not taken into account, nor were the costs of transmission lines. At this stage in the assessment, the Pelly River scheme was ranked second, after the Yukon River scheme, out of the remaining ten schemes. The area that would be flooded by low or high dams at Granite Canyon is shown in Figure 9.

During the first phase of the planning programme, public information meetings were held by NCPC in several Yukon communities. NCPC informed the public of the information meetings and of the sites being considered, by distributing a pamphlet entitled "Power Development For The Yukon Territory – Choosing The Next Plant." At that time no specific information pertaining to the potential environmental and social disbenefits had been compiled; hence the only information available to the public dealt with the output of the installations and their physical characteristics. A very superficial examination of the potential environmental and social consequences of the various site developments was included in the Sigma report, with recognition given to the inadequacy of such an examination. Little quantitative information was included in this analysis, which simply outlined the fisheries, wildlife, forest, mineral, recreation, historic, and scientific values, and the settlements that would be affected by hydro-electric development. Developments were then ranked according to their potential for conflict with those values. However, because the assumptions made in comparing values, in order to

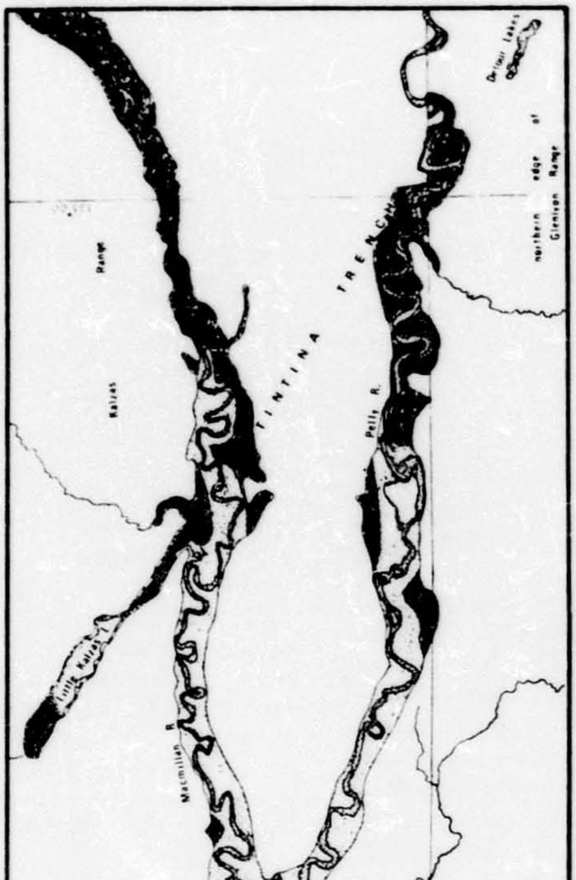


Figure 9 Potential Flood Zones of Pelly–Macmillan Rivers Region
Flood zone of low Granite Canyon dam (light shading);
flood zone of high Granite Canyon dam (dark shading)

obtain rankings, were not made explicit, the validity of the rankings must be questioned.

Sigma suggested that the target date for completion of the first plant would be October 1980. The proposed schedule would involve a phase two programme to evaluate leading schemes from Sigma's phase one programme, and for submission of reports to the Water Board and other agencies during 1975. On the expectation that approval-in-principle of a single scheme would be obtained by the spring of 1976, a phase three programme would undertake a complete investigation and environmental impact assessment of the selected site during the remainder of 1976. Application for a water licence would be made by the end of 1976. Final design and construction were planned for 1977 to 1980, with the first unit scheduled to commence operation in October 1980.

It should be noted that this scheduling plan postponed the detailed environmental studies until the third phase when a single site would have been decided upon, and at that time the studies would assess the potential impact and not the value of the renewable resources against the value of the development. The plan demonstrated that the environmental and social impacts and damage to other resources of the region would not be considered in a decision on the choice of a single site for development. Social and environmental impact studies were to have been initiated in the spring of 1976, which would have allowed only six months of study and analysis before the proposed application for a water licence in the fall of 1976. Such scheduling meant that social and environmental concerns would also be excluded from consideration in the decision to grant a water licence, since they could not be adequately researched in that time.

At the preliminary public hearings in December 1974, opposition was expressed to the process of decision-making whereby the public was kept uninformed of alternatives and of social and environmental costs, since the studies that could supply such information were non-existent. The Yukon Game Branch subsequently recommended that detailed environmental information of first priority sites be made available to the public for their informed participation before a decision is made.[125] Because the expected load forecast is dependent on mining development, including possible construction of a smelter, and since the course of such development is presently uncertain, NCPC postponed all further plans for assessment until such time as the course of mining development is established. This postponement is still in effect.[126]

Mining

While mining exploration has been extensive over a long period of time in parts of the defined region, and claims have been staked, no major ore deposits have been found as yet. At present the only producing mine that affects the Pelly River system is the Cyprus Anvil lead-zinc mine at Faro. There is high potential for additional mining development in this region, since the Anvil Range promises to have one of the most valuable mineral reserves in the Yukon.[127] The region of potential mineral wealth is estimated as being approximately 1,600 square kilometres. The proven reserves of the combined Faro, Vangorda, and Swim deposits are over eighty million tons of mineable lead-zinc. The Grum deposit was discovered in the Anvil district after 1972, a find which brings the aggregate proven reserves of this region to nearly 150 million tons, making it one of Canada's richest lead-zinc areas.[128] Tempelman-Kluit suggested that, with the discovery of the Grum deposit, the long life of lead-zinc mining in the Anvil region is assured, and the establishment of a smelter in the area would now be economically viable.[129]

Smelting

Since the mid-1960s, consideration has been given to the possibility of establishing smelting facilities in the Yukon. The potential for establishing an effective smelting operation, particularly for lead-zinc and silver, depends on the availability of suitable carbonaceous reductants (such as coking coal), low-cost energy, reasonable freight costs, and a reliable long-term source of concentrates.[130] Provision was made in the federal government's contract with Anvil Mining Corporation for the firm to conduct a feasibility study of a smelter to process Anvil's lead, zinc, and silver.[131] While the development of new mines and construction of a smelter may take place outside the defined region, their effects are not limited to their immediate locality. Such developments would require the power loads which would justify an application by NCPC for the construction of a hydro plant.

Railroads

A number of alternative railway routes have been proposed for the Pelly-Macmillan region. The main impetus for railroad development in the region is the need for cheap transportation for moving ore to tidewater ports. Carr and Associates noted that a major consideration in planning new railroad facilities is that the main body of potential ore deposits, which would require transportation, can be expected to lie close to the Tintina Trench. A road bed along this trench would result in considerable savings in construction costs. This route lies close to known coal deposits, and forest resources have some potential for sawmill and pulp and paper logging. Interest in developing these resources is already high. The Carr report concluded that new extensions of the British Columbia rail lines should enter the Yukon at Watson Lake and proceed northwestward. They also noted that the distance which the railroad should proceed northwestward along this path warrants careful economic appraisal.[132] It appears that the probable route would follow the highway from Watson Lake to Ross River and on to Carmacks. The line would provide a north-south transportation route into the region, and could transport ore from Faro to tidewater at Prince Rupert at a much lower cost than the existing truck-rail route to Skagway. In a study of railway extension alternatives, Canalog Logistics Ltd. and Canadian Pacific Consulting Services Ltd. proposed an extension from Carmacks to Dawson that would cross the Pelly River just below Pelly Crossing.[133]

The White Pass and Yukon Corporation examined the possibility of extending a rail line from Whitehorse to Faro via Carmacks. This extension would provide cheaper transportation for ore concentrate than is presently provided by the truck-rail system.[134] Slaney and Co. Ltd. outlined the potential environmental impact of this proposed rail extension.[135] MPS and Associates noted that extension of the White Pass and Yukon line to Faro would provide an ore transport route to Skagway, but that the costs would be slightly higher than those of the proposed British Columbia Rail Road extension.[136] However, Romoff suggested that the potential tonnages hauled on the extended wide-gauge BCRR might not be large enough to make the operation economically feasible; the same tonnages would likely make operation of a narrow-gauge line economically feasible.[137] However, construction of a smelter would reduce the volume of exported mineral concentrates to the economic detriment of railway transportation.

Transportation of Oil and Gas

On 5 May 1976 Foothills Pipe Lines Ltd., Alberta Gas Trunk Line, Westcoast Transmission Company, and Northwest Pipeline Corporation agreed to sponsor a pipeline to transport Alaskan gas to American markets by a forty-two-inch diameter pipeline. This pipeline was routed to pass through the southern Yukon along the Alaska Highway, by which it would enter British Columbia. Applications for the Canadian portion of the Alaska Highway Pipeline project were filed with the National Energy Board (NEB) and with Mr Allmand, the Minister of Indian Affairs and Northern Development, on 31 August 1976. Subsequently the project was redesigned to provide a forty-eight-inch diameter pipeline, and revised applications were submitted accordingly.

On 19 April 1977 Mr Allmand established the Alaska Highway Pipeline Inquiry, with Dean Kenneth Lysyk as chairman of a three-person commission. The task of the commission was primarily to examine the social and economic impacts of the project, to report on the attitude of the people of the Yukon, and to make recommendations regarding identified major concerns by 1 August 1977. The Minister of Fisheries and Environment established an Environmental Assessment Review Board to assess the environmental impact of the pipeline within the same time frame. If the pipeline project were approved in principle, another inquiry would be established to produce a final socio-economic impact statement and to recommend terms and conditions for construction and operation. On 4 July 1977, while the Alaska Highway Pipeline Inquiry was still being conducted, the NEB recommended approval of the Alaska Highway route across the Yukon by Dawson and the Klondike Highway to Whitehorse and thence south to British Columbia. Mackenzie Delta gas could then be routed by the Dempster Highway to link with the Klondike Highway. None of these routes has been studied.

During the Lysyk Inquiry several participants recommended that the Tintina Trench be considered as an alternative route, since major areas of mineral potential were adjacent to or east of the trench. It was hoped that gas would be available to mining projects as a source of power. However, Lysyk stated that Foothills proposed to limit the supply of natural gas in the Yukon to residential and commercial uses, and had not studied the economics of supplying gas for industrial use. He recommended, however, that the Tintina Trench be studied, together with other alternative routes, before a final decision on routing was made. In summary, Lysyk recommended that approval-in-principle be given to Foothills, on the following conditions: that construction be delayed a further year beyond Foothills' proposed schedule, to allow for agreement-in-principle and implementation of some of the terms of settlement of a Yukon Indian land claim; that a single planning and regulatory agency be established to plan, control, and monitor all aspects of pipeline construction and activity; and that a minimum of $200 million be paid by the pipeline company into a fund to provide compensation for inevitable social and environmental damage.[138]

If the Klondike Highway route is chosen, the pipeline would cross the Pelly River in the defined region at Pelly Crossing. If the Tintina Trench route is chosen, the pipeline would cross the Macmillan River where the latter crosses the Tintina Trench and would then follow, with or without crossing, the Pelly River along the trench. In this event, feeder lines would have to be constructed to supply natural gas to the settlements along the Klondike Highway. Subsequent development would probably include looping of the pipeline to increase capacity and, within the concept of a corridor, construction of an oil pipeline and possibly an extension of a road and railway system. If electrification of the pipeline is economically feasible, there would be pressure for development of hydro power, although the site chosen would be affected by the choice of the pipeline route.

Parks and Other Reserves

In 1972 the McArthur Game Preserve was proposed as an IBP site (Figure 8). The suggested boundaries of this site, and of the sanctuary, include the narrowest section of the Tintina Trench, where the fault is approximately five kilometres wide. Little Kalzas Lake occupies about three of these five kilometres. A formal application for this site has not yet been submitted, since no decision has been made on the IBP sites that were submitted for approval in September 1975.

No parks have been proposed within the defined region. However, areas with potential for outdoor recreational development were identified on maps of the Land Use Information Series.[139] These include cottaging, boating, and family beach activities along Little Kalzas Lake. The Pelly River between Faro and Pelly Crossing is relatively undisturbed, and was classed as having good recreational potential for canoeing and camping.[140] The Pelly River is also an historic route. The Macmillan River is undisturbed throughout its course. It has potential for white water canoeing, and would be classed as a wild river.[141]

(c) Potential Resource Use Conflicts

Lakes and rivers are characterized by annual and seasonal changes in water levels and in the rate and volume of water flow (i.e., discharge). These changes are known as the natural hydrologic regime. This regime not only affects the physical and chemical nature of lakes and rivers, but it also profoundly affects all aquatic and terrestrial life associated with such water bodies. Some of these relationships were briefly described earlier as they related to the Mackenzie and Great Bear rivers in the Northwest Territories. Others will be discussed in more detail below, as they relate to the Pelly and Macmillan rivers.

Construction of a storage reservoir above Granite Canyon or at any other site on the Pelly-Macmillan river system would greatly change the normal hydrologic regime of the river both below and above the dam. Below a dam at Granite Canyon, the existing annual pattern of discharge would be virtually eliminated. At present, the mean monthly discharge of the Pelly River at Pelly Crossing ranges from a low of 47 cubic metres per second in May to a high of 1,428 cubic metres per second in June. With reservoir operation, the discharge below Granite Canyon would be maintained at roughly 224 cubic metres per second to 322 cubic metres per second over the entire year.[142] Rising discharge and rising water temperature in spring are known to act as cues which initiate spawning runs of spring-spawning species of fish.[143] With the construction of a reservoir, these two environmental cues would be either eliminated (rising discharge) or retarded (rising temperature). As a consequence, the spawning runs of many fish species could be lost or retarded in the lower Pelly River. Stabilization of flow would result in the loss of the pattern of annual flooding of shoreline areas, causing the loss of spawning areas for pike. Under the normal fluctuating flow regime, some silt accumulates during times of low discharge and is removed during times of seasonal high discharge. With the loss of the annual flushing of the river channel, gravel spawning areas would accumulate silt and in time be destroyed, as would associated fish-food organisms. Change in the hydrologic regime below Granite Dam would cause fish production in the lower Pelly River to decline, and consequently sport and subsistence fisheries for grayling, northern pike, chum salmon, inconnu, and broad whitefish would be damaged.

Creation of a storage reservoir above the dam would eliminate the normal river regime, and establish a regime that is still very different from that of natural lakes. Natural lakes are at or near their lowest levels in the fall, when ice forms. Levels drop very little during the winter. Conversely, water levels of reservoirs are usually highest in the fall, when ice formation occurs, and then steadily drop throughout the winter in order to maintain the required production of power. This drop is called "drawdown," and is of far greater magnitude than that occurring in lakes. The difference in height between a low and a high dam at Granite Canyon is 33.5 metres, but to raise the water level this 33.5 metres would involve flooding 272 square kilometres more land area. The wide range of water level fluctuation in such a reservoir would result in alternate flooding and dewatering of extensive land areas.

Under the conditions of a 14- to 15-metre abnormal winter drawdown, the littoral areas of a reservoir are exposed to freezing and desiccation. Plants of aquatic and riparian communities cannot establish themselves under these abnormal conditions, and few invertebrate species are sufficiently mobile to maintain their preferred depth as water levels rise and fall. Consequently, the productivity of the reservoir area would be greatly decreased for fish, birds, and mammals that are dependent on such communities at different seasons. Beaver and muskrat would be eliminated. Large areas of moose wintering range would be totally lost, and the loss of river valley communities would probably decrease the carrying capacity of upland areas for many furbearers.

The abnormal regime of widely fluctuating water levels in areas of unconsolidated frozen materials would result in prolonged instability of shorelines,[144] which, aggravated by wave action, would result in increased siltation and turbidity during the summer, with further reduction in productivity. Finally, the abnormal pattern of water level fluctuation would result in freezing and desiccation of eggs that are deposited by fall-spawning fish within the zone of winter drawdown, while eggs of spring-spawning fish deposited in shallow water could be subject to "drowning" from lack of oxygenated water as water levels rise.

The Pelly-Macmillan river system contains a valuable resource in the form of hundreds of kilometres of waterways that are largely free of natural barriers to fish movement. This feature accounts for the large numbers of anadromous and freshwater fish which use this system for movement between critical spawning, rearing, feeding, and overwintering habitats. Several developments proposed for this region would create barriers to such essential movements. Hydro-electric dams at Braden's and Granite canyons would have the greatest potential impact on migratory fishes, since these sites block access to all upstream areas of both the Pelly and Macmillan rivers. Greater knowledge is required to design fishways at dams that will facilitate the passage of all species of fish. Chum salmon will not attempt to negotiate any major barriers to migration.[145] Local movements of northern pike may also be stopped by a dam, since none of this species was observed to traverse the fishway of the Whitehorse Rapids hydro-electric dam, even though individuals did congregate below the dam.[146]

Most species that will use a fishway probably experience some delay in migration. Fish may be delayed while locating the entrance to the fishway. Chinook salmon are attracted to areas of strong current, and will move toward the tailrace of the dam rather than to the weaker current of a fishway.[147] Some fish are also delayed by a reluctance to enter the shaded areas within a fishway.[148] At times of peak movement, delay may also result when the capacity of the fishway is not great enough to handle all the fish in a short period.[149] Gordon et al. reported that between 28.5 and 64 hours were required for chinook salmon to traverse the fishway at the Whitehorse Rapids Dam,[150] the vertical rise of which is 16.8 metres. Salmon would therefore probably require a minimum of approximately 75 to 130 hours to traverse a fishway at Granite Canyon on a 48.8-metre dam (Low Granite Canyon Dam). Salmon that have already travelled long distances up the Yukon River, and species that cease feeding during spawning runs, are vulnerable to stress caused by the excessive energy expenditures and prolonged delays that are involved in surmounting hydro-electric dams by fishways.

Once above the dam, fish are faced with another physical barrier in the form of the reservoir. For species which home to spawning areas, migration may be further delayed while they attempt to relocate the migratory route. Generally the lack of current, greater water depth, and greater area can all result in an increased amount of random wandering by migrating fish while in the reservoir. Lack of current in a large area also delays downstream migration of juveniles. The inability of fish to locate the outlet of the reservoir can result in further delays at the face of the dam, as was observed with salmon at the Whitehorse Rapids Dam.[151] Many downstream migrants may be killed by being swept through the turbines or down the spillway.[152] Direct mortality of juvenile salmon passing through the Whitehorse Rapids Dam is as high as sixteen to twenty percent.[153] Once below the dam, further problems of abrupt temperature and pressure changes may be encountered by migrating fish.[154] Fish that have successfully passed through the turbines or down the spillway may be temporarily stunned, making them easy prey for predatory fish and birds.[155] All these factors can reduce the numbers of downstream migrants. Stress approaches catastrophic levels when it has reached the stage of eliminating ten percent of the downstream migrants.[156]

For fish populations of the Pelly-Macmillan river system, the overall impact of mainstem developments will be greater than that of developments on tributary streams. Fish species or populations which do not complete their life cycle entirely within the Pelly-Macmillan system will be most vulnerable to damage from mainstem developments. Delays, injuries, and direct mortality of spawning migrants or juveniles will all contribute to population declines of the species affected. Delay or total blockage of feeding migrations can result in a reduction of carrying capacity within the system, and can also contribute to declines in the growth rates of fish. Chum salmon will likely be eliminated from all areas above Granite Canyon if a dam is constructed in that region. Chinook salmon populations may decline steadily, as they have above the Whitehorse Rapids Dam.[157] A series of mainstem developments on the lower Pelly-Macmillan system will probably eliminate chinook salmon from all upstream areas. Inconnu, arctic grayling, and broad whitefish runs will likely be reduced in the lower Pelly River if a dam is constructed at Granite Canyon. Populations of resident species such as northern pike, lake whitefish, least cisco, burbot, lake trout, and round whitefish will probably experience only slight declines in limited areas near the points of migratory route blockage. The overall effect of migration route blockage will be to decrease the carrying capacity of the Pelly-Macmillan river system. Fisheries dependent upon large runs of migrant fish species will suffer the greatest damage. Localized fisheries for resident species will experience declines in areas near points of migration route blockage.

Other kinds of barriers that result from any kind of construction involving river or stream crossings include: improperly designed culverts; ice build-up within culverts; improperly located or designed bridges; coffer dams which constrict river channels; berms or borrow sites within alluvial flood plains; and logs, soil, and debris that are left from ice bridges and winter construction sites. Unlike reservoirs, hydro dams, and fishways, these barriers can be avoided by appropriate regulations.

A major limiting factor for populations of stream fish in northern regions is the availability of suitable overwintering areas. Any activity that affects water quality or physical conditions in these overwintering areas could be detrimental to entire populations of fish. The proposed smelter at Faro would require approximately one million gallons of fresh water per day.[158] To this need could be added the water requirements of the mine and the town site of Faro. During the winter months, pumping from streams to meet such water demands could draw down water levels in critical overwintering areas, causing mass mortality of fish and developing embryos. Another major threat to overwintering fish populations is the addition of waste material to water courses. With development of new mining activities in the region, the winter water quality of the Pelly-Macmillan system could be severely taxed. During the winter, effluents and other organic substances such as oil may also enter streams from settlements and construction camps. During the summer, fish might avoid areas where wastes are entering streams; but during the winter the large numbers of fish restricted to the overwintering sites cannot escape if the water quality should deteriorate. As a result, entire populations of fish may be eliminated from the system.

There is a high potential for conflict between development of the mining industry and maintenance of water quality in the Pelly-Macmillan system. Tailings ponds are used to remove most of the toxic components produced by mines before waste water is released into receiving waters. The Cyprus Anvil mine has already suffered one retaining dike failure,[159] and one known accidental release of a large amount of cyanide into the tailings area.[160] Both of these mishaps resulted in large quantities of toxic materials entering the Pelly River system. At present, waste water containing a certain amount of toxic material may be released into receiving waters. Such disposal methods have been allowed because pollution standards apply to the quality of receiving waters and not to the quality of the effluent released.[161] Using these standards, dilution of toxic materials is depended upon to eliminate lethal effects. Bérubé et al. suggested that this practice fails to consider the harm done during dilution, and does not account for the consequences of the continued introduction of sub-lethal amounts of toxic substances.[162] Such practices can result in acute localized reduction of water quality, near the point of effluent discharge. As the number of mining operations is increased, these disposal methods will tax the water quality of the Pelly-Macmillan river system more and more heavily.

Sub-lethal concentrations of toxic substances such as copper and zinc, and cyanide and zinc, act synergistically causing high mortality of fish, even though the level of the individual substance is "safe." Fish that are already stressed, as from migration or food shortage, may succumb to sub-lethal concentrations of a single toxic substance. Sergy suggested that the effects of heavy metals may also be more serious than predicted, during the winter when dissolved oxygen levels are already low.[163] Heavy metals may also be consumed and accumulated by benthic invertebrates. Fish such as longnose suckers and lake whitefish, which might then consume the contaminated invertebrates, could develop high systemic concentrations of heavy metals. If the levels were sufficiently high, certain species of fish in the

Pelly-Macmillan system could become unfit for human consumption. Birds and mammals dependent on fish could also be affected. Salter noted that a by-product of smelting ore from the Anvil region would be the production of 200,000 metric tons of sulfuric acid per year.[164] High concentrations of heavy metals may also be emitted by smelters. Clearly, the control of such emissions and the safe disposal of large amounts of sulfuric acid must be included in the economic cost of the operation of a smelter.

Developments associated with a Tintina Trench corridor would require large quantities of gravel. Gravel removal from rivers is clearly incompatible with the maintenance of fish populations, as is the destruction of gravel beds by reservoirs and altered flow regime. Gravel mining operations within the active floodplain of streams can result in increased siltation. Increased siltation is probably the greatest threat to the integrity of streambed gravel deposits. Heavy runoff and erosion from the proposed railroad marshalling yards near Faro, for example, could cause extensive siltation of the Pelly River.[165] If the hydrologic regime is not altered, annual flooding can remove silt deposits and rejuvenate gravel beds, allowing invertebrates and fish to recolonize the disturbed areas. However, there have to be populations of invertebrates and fish available for recolonization; and there are limits to the resilience of populations to extensive, prolonged, and repeated disturbances. If construction of gas and oil pipelines, looping of pipelines, removal of pipelines, extension of roads and railways, trenching, and construction of tote roads from mining exploration are to take place over the next twenty to thirty years, repeated disturbances are inevitable. If fish and aquatic invertebrates are simultaneously subjected to other kinds of disturbance, such as deterioration of water quality from mining or smelting, destruction of overwintering sites, or overharvesting, it is unlikely that populations would continue to be available for the recolonization of disturbed areas. The incremental impact of such development projects may therefore be profound, and to evaluate one project at a time, without reference to the sequence of others, can hardly be called rational planning.

While potential conflicts with the maintenance of the carrying capacity for fish have been emphasized in this section, many of the conflicts discussed will also affect semi-aquatic mammals and waterfowl. Clearly, a reduction of the carrying capacity of the river system for fish will reduce the carrying capacity of the region for mammals and birds that are dependent on fish as a food source. Wildlife resources will also be decreased by loss of habitat and by harassment through ease of access to populations of animals that are sensitive to human activities. Loss of productive land for small-scale selective logging and for garden produce will also further decrease the renewable resources of the region. Competition for space on well-drained land surfaces will be acute in the Little Kalzas Lake area of the Tintina Trench. While river valleys may offer the easiest routes for construction of transportation corridors, they are also among the most productive areas for renewable resources. This becomes a serious consideration if evaluated in relation to the continuing high rate of loss of productive agricultural land in southern Canada. Over two million acres of farmland were lost over the 1961-71 decade. This is a rate of 780 acres per 1,000 increase in urban population,[166] and there appears to be little, if any, change in this trend.

Finally, the value of the natural and, in some areas, wilderness character of the Pelly-Macmillan region must also be considered. It is a value that is important to Yukon residents,[167] as well as to non-residents. Masse noted that remote areas can fail to provide a balanced lifestyle for residents, since work is usually available but social amenities are few.[168] Under such conditions, residents place a high value on outdoor recreational opportunities. To the extent that these opportunities contribute to the well-being of the area's residents they also contribute to the productivity of local workers and to the stability of the local labour force, reducing the number of transient workers. It is estimated that ninety percent of all recreation in the Yukon Territory takes place in valley bottoms, centred largely on lakes and rivers, since these contain most items of natural and historic interest. The territorial government has included Campbell's exploration route, down the Pelly River to Fort Selkirk, as one of the main river themes in its parks proposal.[169] The Macmillan River is one of the least disturbed rivers in the Yukon.[170] Both rivers are navigable for most of their length, and are rated as good scenic canoeing routes.

Slaney and Co. suggested that an undisturbed buffer zone is required between all transportation routes and water courses.[171] However, a zone wide enough to eliminate noise from such sources as heavy equipment operation, compressor stations, vehicle traffic, and increased numbers of people, and wide enough to avoid disturbance to wildlife, would probably be unacceptable. If mines were brought into production at a carefully controlled rate and in relation to presently existing transportation routes, conflict with the recreational potential of the region could be minimized. On the other hand, construction of a smelter would create an imperative to increase the rate at which mines were developed and at which power was required. It would therefore constitute a conflict with the recreational potential and the renewable resource potential of the region which could not be reconciled by any mitigatory measures. Similarly, construction of hydro-electric developments on the scale envisaged for the Pelly and Macmillan rivers presents an irreconcilable conflict with the productive capacity of these rivers and their valleys for renewable resources, with their recreational potential, and with perception of the wild nature of their beauty. Accelerated development of industrial projects based on depletion of non-renewable resources produces limited short-term benefits. Benefits which accrue from maintenance of wild rivers are permanent and, given the present trends of development and population growth, will increase in magnitude with time.

V Social-environmental Relationships

Social values that relate to diverse features of northern ecosystems have evolved from past patterns of land use. But land use is not limited to material or physical use; it also includes psychological use, which is perhaps defined by perception. Although these kinds of uses are not always easily separated, social values will be discussed from both perspectives.

As Taylor observed, most people do not need to be given security, but need to achieve it for themselves; they need the conditions in which self-help and independence are possible.[172] Such conditions are inherent in a traditional subsistence economy, and are important values in the social-environmental relationships that are part of such an economy. Conversely, total dependence on a wage economy confines people to a situation over which they have no control. The forces which determine levels of unemployment, inflation, and recessions are remote, complicated, and impersonal. Neither economists nor politicians can accurately predict, much less control, such phenomena. In the past, as long as the productivity of the land remained sufficient for populations in the North, the people were able to adjust to natural disturbances – such as fires and fluctuations of animal populations – by a natural mobility and by changing their dependency from scarce species to those that were temporarily more plentiful. That the land offers a basis for a measure of security and self-determination is one reason for native peoples' emphasis on the importance of land, compared to compensation by cash, in negotiating a claims settlement.

Insofar as the productive capacity of the North has been impaired by demands for economic growth and therefore industrial developments, and insofar as the population of the North and the demands made on renewable resources have increased, there is necessarily a dichotomy in attitude towards industrial development. At the Mackenzie Valley Pipeline Inquiry, the majority of the residents of Fort Norman spoke of their concern for the land, and against construction of a pipeline, at least until land claims were settled. Chief Paul Andrew argued for maintenance of the option of a subsistence economy:

> *We want to teach our children too, we want to teach them how they can survive off the land if necessary. I am sure that with the unemployment situation in Canada, the Territorial Government realizes that all of the people that graduate are not going to be guaranteed a job. So we want to teach our way of life. So that when necessary, they can go out when they do not have employment, . . . they can go out somewhere where they can live prosperously also. That has not been the case in the past and there is a lot of unemployed people right now that are not entirely capable of handling themselves adequately in the bush.*[173]

This amounts to an independent form of unemployment insurance. Such programmes have been initiated at Fort Norman and at Fort Providence[174] for younger members of the communities. These programmes are seen as a way not only of learning self-reliance, but of learning traditions related to the land. However, fear that these measures will be inadequate if renewable resources are insufficient, and a need to obtain some cash income, may have contributed to the decision of sixty-nine Fort Norman residents to sign a petition in favour of early construction of a Mackenzie Valley Pipeline. The petition questioned how young people, now in high school, would survive for ten years if there were no development.[175] That other options for development might be available has not been apparent either to native peoples or to Canadians as a whole. This point will be discussed later in this report. That there is growing dissatisfaction with a way of life that is dominated by an industrial wage economy is evident in many ways, but specifically in the Yukon by an influx of southern Canadians who hope to pursue a subsistence way of life supplemented by a limited involvement in a wage economy. In this respect, their values are similar to those of a large number of native peoples in the North.

Testimony and mapped exhibits presented at the Mackenzie Valley Pipeline Inquiry and the Alaska Highway Pipeline Inquiry, and evidence from the Inuit

Land Use and Occupancy Project[176] document patterns of land use which illustrate the dependence of indigenous peoples on environmental features associated with high seasonal productivity. These features include good fishing areas at mouths of rivers and outlets of lakes; areas of salmon spawning concentrations and caribou concentrations, particularly the migration routes of both groups of animals; areas of early ice breakup and wetlands where waterfowl are seasonally concentrated; areas where seals are abundant; routes of easy access to such areas; and camping places which are favourable for harvesting berries and diverse animals, according to seasonal availability. Also of importance in winter are valleys which provide protection from wind, access to ice fishing areas, and, in forested regions, access to moose winter ranges and supplies of fuel. The values associated with such areas are related to the capacity of the lands and waters of the North to provide the necessities of life and to provide the conditions whereby communities can achieve an adequate measure of security and independence in ways that emphasize co-operation. At the community hearings in Fort Norman, Robert Clement expressed some of these values:

> *I remember a few years ago, the people lived in their homes. They cut their own wood and hauled their own water. People were happier then, when they didn't have to depend on the government all of the time. We were happier then and we could do it again.*
>
> *But look what has happened. Now the government gives the people everything, pays for the water and the fuel and the houses, the education. It gives the people everything, everything but one thing — the right to live their own lives. And that is the only thing that we really want, to control our lives, our own land.*[177]

Other social-environmental values relate to areas that are associated with historical events and which provide links with the traditional use of the land. Awareness that such areas remain unchanged gives a feeling of cultural and spiritual continuity:

> *Our ancestors used to go to certain places where we don't go very often anymore, but animals still use these places. Things our ancestors made should never be destroyed by mining and oil companies. These places are seen and used by people today. Even when we grow old they will still be there. (Peter Alogut, Southampton Island)*[178]

These are universal values common to all peoples. Places where historic events occurred, even if the history is almost lost in myth and there is nothing to mark the place but the memory of a name, still evoke strong feelings in those to whom such places constitute a part of their roots as a people.

A feeling of continuity with the past (and perhaps therefore the future) is an important component of a feeling of identity. But there is more to a feeling of identity than social traditions and values. In a psychiatric investigation of the role of the non-human environment in normal development and in psychosis, Searles concluded that "there is within the human individual a sense, whether at a conscious or unconscious level, of *relatedness to his non-human environment.*"[179] The benefits of a sense of relatedness with the non-human environment were summarized as assuagement of fear and anxiety, the deepening of an individual's sense of his own identity, and consequently a deepened appreciation and acceptance of his fellow man. Individuals, of course, also turn to others for assuagement of fear and anxiety. But people tend to go away, to change, and to die. A sense of continuity is not always to be found in human relationships, nor in the society that we have evolved. But it is to be found in the land. In societies that are permeated by the kind of violence that originates from both suppressed and conscious fear, it is no trivial matter to destroy resources to which men of diverse ethnic origins, and of an entire spectrum of "sophistication," have turned for reassurance.

Social-environmental relationships form an area of the human mind that has been explored more by literature than by science. It is an area that cannot be dismissed lightly under the terms "economic" or "recreational." While not well understood, it must be allowed recognition and evaluation in decisions relating to northern resources and land use, since the emotional investment in such relationships may be very great. The long-term social values that are considered here as being relevant to northern resources and land use are: the means for achieving a measure of material security; a sense of identity; a sense of community, or of relatedness; a source of reassurance that has much to do with awareness of beauty, and that goes beyond the reassurance of human relationships; and a sense of continuity in time and place — of a quality of endurance in a world of change.

VI Constraints

(a) Human Constraints

Whatever new forms social development may take, it must recognize both human constraints and environmental constraints if social and biotic communities are to retain stability and survive. An example of a human constraint is the limit of the ability of individuals to withstand the stresses and demands of human crowding without losing a sense of community, and consequently the ethical responsibility that is inherent in a sense of community. Another example is the limit of human ability to withstand various changes, especially accelerated rates of change, without resorting to violence, suicide, alcohol, or drug addiction. Changes that are destructive of a sense of continuity, or that impose a sense of alienation and helplessness, may preclude any possibility of socially acceptable adaptation. A third constraint is the human requirement for experiencing natural beauty under varying degrees of solitude, at least occasionally, or for the knowledge that it can be experienced when needed. It is not within the scope of this study to discuss human constraints or their variability, but these examples demonstrate their relevance to environmental considerations and to any discussion of conflicts in the use of northern resources.

Freedom is a social goal to which we pay lip service; but if we agree with Hegel that "freedom is the recognition of necessity," then social freedom is unattainable (irrespective of social constraints) without recognition of the necessities imposed by the life-supporting system of the land.

(b) Environmental Constraints

Some environmental constraints that have been defined are peculiar, either in kind or degree, to the North. An example of one such constraint, which has recently been the subject of intensive research, is that of permafrost. Construction in areas of continuous or discontinuous permafrost has had to adapt its technology to accommodate that constraint, and the process is not yet complete. Moreover, there are other constraints to which technological adaptation, if feasible, would be prohibitive in terms of energetic, environmental, social, or economic costs.

Biological productivity in the North is a resource with inherent constraints.[180] Marine productivity ranges from 2 grams to 3,000 grams of organic matter per square metre per year. It is lowest in arctic waters, and generally higher where arctic and subarctic waters meet. Because of ice scour, seaweed communities cannot survive in many coastal areas, and marine plant productivity is restricted to that of small, free-floating, c⁻ ice-attached plants (phytoplankton). The availability of marine productivity to man has been restricted to animals — mainly fish and marine mammals. Except in deltas and some other areas, terrestrial and freshwater productivity in the North are generally low. Terrestrial productivity is limited mainly by poor soil formation, low precipitation, and low input of solar energy.[181] With large areas of low plant productivity, much land is required to sustain populations of the larger herbivores and carnivores. The timing of reproduction in many northern animals, both migratory and resident, is critical and has a very narrow margin of safety. Consequently, there is great fluctuation in reproductive success, or survival of young, from year to year. In addition, the North is characterized by biotic communities with a low diversity of species. Food chains, therefore, are relatively short, and fluctuations in numbers of one species may profoundly affect other species. Cycles, such as those characteristic of snowshoe hare and lynx, are common in the North. Slow growth rates are characteristic of other animals, such as marine invertebrates and fish. These various constraints mean that the concept of maximum sustainable yield, developed in relation to the management of renewable resources in southern temperate areas, cannot be applied to the North. Management must take into account northern constraints.

Native peoples of the North have evolved their ways of living in relation to fluctuating and relatively low levels of biological productivity; and of necessity they have been mainly dependent on wild animals, rather than on wild plants.[182] Most terrestrial plants are unavailable to man as a form of energy, because of his inability to digest the fibrous components which form the major part of such plants. While this dependence on wild animals has been reduced with the introduction of imported foods, it is still of considerable importance in many regions. In a field study made in 1951-52 of a group of northern Athapascans at Lynx Point on the Mackenzie River, Helm observed that at least half of their total food intake by volume consisted of wild flesh or fish.[183] In a study of Fort Norman and Fort Franklin communities, Weir stated that over half of the food consumed was derived from local resources.[184] Macaulay and Boag found that, in a year of good production, waterfowl formed the major source of protein over the spring-to-fall period for an Indian community near Hay and Zama Lakes in northern Alberta.[185] In one example in the Yukon Territory, it was stated that up to ninety percent of the protein requirements for a family were obtained from wild game and fish.[186] However, the Yukon imports almost all of its food.[187] The value of country food to native peoples was demonstrated in terms of nutrition by Schaefer[188] and in terms of replacement and intangible values by Usher[189] and Rushforth.[190]

While certain kinds of foods will probably always need to be imported, northern communities should at least be self-sufficient in terms of protein; and in a world that has insufficient protein for its population, that is no trivial matter. However, there is a caveat. Non-human predators also require a food source, and nutrients need to be returned to the soil and water. Food webs may be complex, and what is not harvested at one level may be harvested in another form at another level. The moose that "got away" may be consumed by wolves and later scavenged by foxes whose fur grew rich and lustrous on the proceeds. Some overwintering mortality of juvenile muskrat may be a necessary condition for the well-being of mink. "Waste" is a necessary part of harvesting, and must be considered in any estimate of long-term harvest potential. However, the recent incidents of wasteful killing described by Strang,[191] where caribou were slaughtered for their tongues or killed and wounded in large numbers, is a practice of excess that can only lead to reduction or extermination of a population.

Because of energy lost at each stage of conversion, from solar energy through photosynthesis to chemical energy in plants, to chemical energy in animals, and finally to man, the major constraint on the carrying capacity of northern lands for man has been that of energy. Because of climatic conditions, the North is a place in which it is energetically expensive to live year round. If the same standard of living that is characteristic of most southern Canadians is required, it is energetically exceedingly expensive, and such living has only been maintained by importing energy, and products that have required energy for their manufacture elsewhere. It is hardly surprising, therefore, that the North is a region of immense distances with a relatively low population. To consider this area a vacuum that must be filled with people and cities, as was the vision of the 1950s and '60s, is nonsense. So is the feeling expressed by Maurice Strong that Canadians must be prepared to defend their right "to a disproportionate share of the world's territory and its resources."[192] It would seem appropriate to remember Ambrose Bierce, who lived south of the 49th parallel and defined man as, among other things, a species which "multiplies with such insistent rapidity as to infest the whole habitable earth and Canada."

(c) Population and Constraints

A study concerned with prediction of conflicts obviously must address the question of population growth in the North. While policy and legislative changes may be recommended to avoid or reduce conflict in the use of northern resources, population increase alone may make avoidance and even reduction of conflict impossible. The constraints on biological productivity discussed in the previous section clearly indicate the necessity of considering population in the North within the Canadian context. The conclusions of the Science Council of Canada are relevant:

> *We would like people to understand that Canada is not now well prepared for the impact of its predictable population expansion to the year 2000, even with very limited immigration, because we have not yet solved our short-range energy problems and have hardly begun the planning and research required to ensure a continuing supply of energy in the long range future.*
>
> *Prime agricultural land with good climate, which is very scarce in Canada, is as yet unprotected except in British Columbia. We have not yet taken seriously the problem of ensuring our own future food supply, much less protecting our position as an exporter of food. We are only beginning to take a systematic and planned approach to the management of our natural resources, including ensuring that they are used frugally and that they are processed as far as possible within Canada before export. . . . We have not yet thought through Canada's role in an overcrowded and hungry world and are just beginning to talk about a conserver society that would reduce Canada's consumption of food, energy and resources and make possible a larger contribution to underdeveloped countries.*[193]

Population changes in the Northwest Territories are shown for 1911-76 in Table 1. In the thirty-year period from 1911 to 1941, the population almost doubled. In the next twenty-year period from 1941 to 1961, the population again nearly doubled; while in the fifteen-year period from 1961 to 1976 another doubling occurred. The corrected preliminary population counts for 1976 gave a total population of over 46,000. Lu and Mathurin gave twenty-eight series of population projections for the Northwest Territories to 1981.[194] The series differed according to the assumptions made about fertility, mortality, and migration. Their highest projection for 1976 was 43,208 and for 1981 was 50,298. Since their highest projection for 1976 was an underestimate, given the same assumptions their highest projection for 1981 would also appear to be an underestimate.

The sharper rate of increase from 1951 to the early 1960s appears to be largely a function of an increased birth rate with a decreasing death rate. The decreasing death rate probably resulted from achievement of a more effective

Table 1
Population of the Northwest Territories from 1911 to 1976

Year	Total	Indian	Inuit	Other[b]
1911	6,507			
1921	8,143			
1931	9,316			
1941	12,028			
1951	16,004			
1956	19,313			
1961	22,998			
1966	28,738			
1971	34,805	7,186	11,400	16,225
1976[a]	> 46,600	—	—	—

Source: Dominion Bureau of Statistics, *Canada Yearbook*, Annual Publication, Queen's Printer, Ottawa.

[a] Corrected population preliminary counts.

[b] Including non-status Indian and Metis.

Table 2
Population of the Yukon Territory from 1901 to 1976

Year	Total	Indian	Other[b]
1901	27,219	3,322	23,897
1911	8,512	1,489	7,023
1921	4,157	1,390	2,767
1931	4,230	1,628	2,602
1941	4,914	1,508	3,405
1951	9,096	1,533	7,563
1956	12,190		—
1961	14,628	2,167	12,461
1966	14,382		—
1971	18,390	2,580	15,805
1976[a]	21,392		—

Source: Dominion Bureau of Statistics, *Canada Yearbook*, Annual Publication, Queen's Printer, Ottawa.

[a] 1976 Population Preliminary Counts, Statistics Canada.

[b] Including non-status Indians and Metis.

screening programme resulting in early detection of tuberculosis cases. The death rate appears to have been constant from 1964, while the birth rate and therefore natural increase rate has slowly declined. The continued high rate of population increase must therefore be a function of net immigration.

Population changes in the Yukon Territory are shown for 1901 to 1976 in Table 2. The decline in population from 1901 to 1921 was initially in large measure a response to the end of the gold rush and latterly a response in part to the 1914-18 war, accompanied by a continued decrease in prospecting. Lu attributed the doubling of population from 1941 to 1951 to an influx of construction workers and military personnel in response to construction of the Alaska Highway.[195] As a result mainly of government assistance, which stimulated mineral exploration and development, the population again doubled from 1951 to 1971, in spite of the withdrawal of military personnel and federal employees between 1961 and 1966. The natural increase rate was high during 1931 to 1961, and subsequently declined. Lu attributed the dramatic fluctuations of the Yukon population from 1901 to 1971 mainly to migration.[196] The average annual growth rate (which includes net immigration) from 1966 to 1971 was 5.0 percent in the Yukon, compared with 3.9 percent in the Northwest Territories and 1.5 percent for Canada.

If population growth rates remain constant, the population of the Yukon Territory would double in just over twelve years, that of the Northwest Territories would double in just under eighteen years, while the population of Canada as a whole would double in a little under forty-seven years. No one can know whether these rates will remain constant, decrease, or increase. However, from 1970 to 1975 the Canadian population growth rate *increased* from 1.1 percent to 1.5 percent. Canada has the fastest growing population of any of the developed countries.[197]

Populations grow in two ways: first, by immigration exceeding emigration (i.e., net immigration); second, by the number of births exceeding the number of deaths (i.e., the natural increase rate). If the natural increase rate declines over a period of time, it does not mean, as appears to be popularly believed, that the population ceases to grow. The population continues to grow but at a slower rate. If it drops to 0.0 percent and remains constant, the population will continue to increase until the number of female children reach menopause. In other words, the population will only cease to grow after about forty years of 0.0 percent increase, or if the rate becomes negative. Data combined for all ethnic groups in the Northwest Territories from 1964 to 1973 showed an almost constant death rate at about 0.7 percent, a birth rate that declined from about 4.3 percent to 3.2 percent, and therefore a natural increase rate that declined from 3.9 percent to 2.5 percent. A natural increase rate of 2.5 percent *exceeds* that of India, which was 2.4 percent in the 1970 to 1975 period.[198] As was previously noted, the continued exponential rate of population growth in the Northwest Territories is a result of net immigration. However, even with no net immigration, the fact that 61.4 percent of the population of the Northwest Territories is under twenty-five years of age[199] indicates a potential for rapid growth. It has been said that the number of Inuit living in the western Arctic a century ago was higher than at present.[200] However, with a high infant mortality rate the percentage of the population under the age of twenty-five during that period would have been much smaller. In other words, the potential for increase would have been relatively low. A knowledge of demography is not necessary for such understanding. It is quite clearly evident:

> *We old people are not very numerous anymore; only the young people are around now. (Lucy Kaunaq, Baker Lake)*[201]

Although populations of native peoples in the nineteenth century may have been higher in some areas of the North than at present, it is not possible to conclude that because renewable resources may have been sufficient for those populations they are sufficient today. There are no reliable estimates, for that period, of populations of the wildlife species on which native peoples depended. One half of the equation is missing. Many of these species were migratory, or highly mobile; so it is reasonable to assume that changes in other regions, particularly in the South, would have affected those wildlife populations and the carrying capacity of the lands and waters in which they ranged. Populations of some harvestable wildlife species obviously have decreased; others may have increased; and some that were not used in earlier times may have potential for future use.[202] We do not know to what extent the renewable resources of the North can support the human populations of the North, but it is a question that cannot be answered unless it is asked. Reliance on non-renewable resources assumes that, at minimum, there will always be a food surplus elsewhere. It has become increasingly evident that this is an assumption that must also be questioned.

Because native northerners understandably see their political strength as being dependent on their numbers, there is a reluctance to think of population growth as a problem in relation to renewable resources of the North. In August 1976, the Committee for Original Peoples' Entitlement made the following statement:

> *Uninformed judgements are made about the so-called population/resources balance which conclude that we can't live on our own resources.... We know that the main problem in expanding the harvest of renewable resources is not the lack of these resources, but capitalization and organization.*[203]

At an Inuit Women's Workshop in September 1975, many of the groups present expressed strong opposition to birth control.[204] It was obvious, however, that there was confusion between contraception and sterilization. It is probable that many non-Inuit women share the same confusion. If a white-dominated government health service advocates birth control to Inuit, Indian, and Metis, charges of racism will inevitably be made, even if the white population itself stringently practises what its health service preaches. There is no indication that the latter is the case. Nevertheless, the problem of population increase and immigration has to be faced, not only as it applies to the North but in the general Canadian context. When populations, regardless of ethnic composition, become too large for the resources of the land, what choices do we leave ourselves? Production of the necessities of life may be one part of the equation, but consumption is the other. Resources can be drastically depleted or destroyed by relatively few individuals each demanding too much, and by too many individuals each demanding only a little. In the short run, equity of per capita consumption matters to people very much. But if the aggregate consumption is too great, then in the long run equity matters not at all. The result is the same.

VII Options for Resource Use

Options in the use of resources cannot be considered separately from ways of living, which in turn involve perceptions of different facets of resources in relation to physical, emotional, and intellectual needs. Clearly this report can only suggest some points or examples that perhaps merit consideration in the exploration of alternatives.

In discussing ecological criteria, the necessity of maintaining the integrity of biotic and social communities was stressed. Any discussion of ways of living is of doubtful value unless it considers the concept of community. The feeling of some of the native peoples of the North towards their communities was expressed by James Wah-Shee: "Our people are concerned in that they want to maintain some sort of control over their own small communities and thereby maintain some sort of control over their own way of life, whether it be traditional or not."[205] That population increase alone may make the avoidance or even reduction of conflict in the use of northern resources impossible, is readily apparent. But it is perhaps less obvious that population increase can be destructive of communities and of a sense of community.

Federal and territorial governments alike have insisted on the necessity of the dominance of an industrial wage economy in the North. Such an economy is largely confined to exploration for minerals and hydrocarbons, and to their extraction and export. As the basis for a growth economy, the extractive industries are heavily subsidized and must endeavour to deplete those non-renewable resources at the maximum rate in order to realize the maximum monetary profit. Future needs for those resources are discounted. The rationale for such a short-term perspective of resource use is that it creates employment and that payment of royalties to the North will provide capital for other economic endeavours. It is a rationale that has been questioned by many people. To date, the most compelling argument against relying *only* on extraction and export of non-renewable resources has been presented by Berger.[206] The onus now lies with the government to test the thesis that large-scale industrial development in the North is the *only* basis for an economy that serves the needs of the people of the North.

It should be apparent that evidence that will refute or fail to refute the thesis must come from the exploration of alternatives. As Berger observed, we have made no serious attempt to explore alternatives, since it was not in the perceived interests of the South to do so. Critics have argued that the alternative of strengthening the renewable resource sector of the economy will destroy the resources that Berger seeks to protect. If we are locked into the concept of a growth economy, then of course we will destroy those resources. But nowhere in his report did Berger endorse a growth economy; on the contrary, he questioned the wisdom of such a concept.

It should also be evident that it will not be easy to explore alternatives. As Livingston observed, "Like ecologic niches, options do not necessarily advertise themselves in three dimensions and living color."[207] It must be emphasized again that this report has no competence to explore alternatives. Such exploration must involve the time and thought and sharing of ideas and experience of many people. It must involve research and experiment and failure. Moreover, it must involve not only the North, since a search for alternatives in the South will facilitate such exploration in the North. The alternatives that are suggested below, therefore, are randomly chosen, but form a continuum. Some are complementary to others and may co-exist at the same time within the same area. But multiple use is not always the best use, and some alternatives are mutually exclusive, either totally or within the same region.

A subsistence economy in the North involves hunting, fishing, gathering and, more recently, trapping. Participation in this way of life may be full-time or part-time. Acting as guides for hunting and fishing trips has historically been a means that many native groups in Canada have used to supplement an income derived from trapping. Fishing, hunting, and wilderness lodges are traditional approaches to recreational development; but in parts of the central Arctic, boat trips for whale watching and observation of other forms of marine life also have potential for the development of recreation. Extension of recreation into the winter, through guided trips by snowshoe and dogteam, would allow native peoples to retain traditional skills associated with such travel, and allow others to learn something of the wilderness value of the North in winter. Clearly a subsistence economy and such forms of recreation are dependent on maintaining large areas of wild, or at least relatively undisturbed, land.

The potential for small-scale agricultural production in much of the Yukon and parts of the Northwest Territories is considerable.[208] Its importance has been underestimated, simply because it is small-scale and does not accord with the imperative of economic growth. The replacement value, particularly of garden produce, to the individual or to the community can doubtless be measured. But the value of such produce as part of a way of life and as a means of increasing self-sufficiency is immeasurable.

Developments that are compatible with the maintenance of communities are those of small-scale secondary manufacturing. Production of leather goods, fur goods, spun musk-ox wool, utensils from antlers and birchwood, snowshoes and fish nets, preserves and liqueurs from wild berries, pemmican, smoked fish, and muktuk are some possible uses of renewable resources that might complement the traditional economy. For local use, lumber and logs and peat for insulation would also be valuable if taken from carefully selected areas. The technology that is involved may be highly sophisticated, and we probably have much to learn from the successes and failures of other northern lands. Small-scale secondary manufacturing has many advantages that are relevant to the North. Most enterprises are labour- rather than capital- and energy-intensive. Many emphasize aesthetics and craftsmanship in the most sophisticated sense, and are therefore intrinsically satisfying to the craftsman who can express his individuality. They do not have to be inflexible, clock-punching, clock-watching systems; they can be organized so that it is sometimes possible to hang a sign on the door saying "gone fishing." They are also a means of retaining small, economically viable communities, socially strengthened by traditions of teaching and learning skills, whose members can enjoy some feeling of control over their own lives and a feeling of a continuity in time, unlike the boom and ghost towns associated with mining. Finally, because such enterprises are varied, they strengthen diversity and independence, in contrast to the industrial system whereby whole communities are subject to sudden, mass unemployment because of a decision made elsewhere.

While the potential for developments dependent on renewable resources has been emphasized in this report, options for development of mineral resources are not excluded by such emphasis. However, the questions of scale and pace of such developments must be addressed if a diversity of options is to be maintained:

> *Loss of diversity, whether it be biological or cultural, is not merely a matter of sentimental regret. Both represent a decline in the number of options open to communities, to nations, to humanity as a whole. Cultural diversity is the source material for solving problems.*[209]

We cannot, however, explore resource use options without understanding the nature of resources. As stated earlier, resources can be classified by our perception of them, and by their properties which determine their response to biophysical laws. How we perceive resources will determine how we use them, and therefore perception must include some knowledge of the properties of resources. The often heard argument that unfavourable economic conditions can destroy a physical resource is erroneous, and assumes immutability of the economic system. Such an assumption was implicit in a statement made by Powis in 1973:

> *Significant adverse changes in exploration capital or operating costs — including taxes and the cost of capital — or in the perceived political climate can convert what previously would have been ore into waste rock.*[210]

An ore deposit may or may not be developed in the immediate future, which may or may not be a good thing, but it can only be destroyed by physical means.

Henderson argued that the choices with which we are now faced are at an evolutionary level of change, and that we have to choose consciously between investing in a course of action now "at the risk of hard-programming our future into irreversible paths, *versus* keeping our options open and funding a diversity of approaches."[211] If we wish for balanced development in the North, then, at minimum, there must be equality in funding between exploration for alternative resource use options and exploration by the extractive industries. The alternatives are matters for discussion, but a prerequisite for intelligent discussion is that the participants be well informed. Public participation in the absence of information is virtually meaningless, as was recently obvious in the Alaska Highway Pipeline Inquiry. It is not just a question of making information available to the public by legislative action. If the necessary information does not exist, it cannot be made available. If we have insufficient knowledge and understanding to identify or evaluate options, then we cannot choose. We have an empty freedom. From the perspective of such awareness, the common predilection of scientists to end their reports with recommendations for further research can be seen, not as a preoccupation with individual spheres of interest, but as an inevitable and continuing human concern.

VIII Conclusions

(a) Policies Affecting Research Programmes

There are basically two levels of knowledge gaps: first, how do biotic communities within northern ecosystems function when man plays a relatively small part within those communities; and second, when man plays a significant part, what will be the effects of his actions? It is not possible to answer questions of the second category adequately without reference to the first. Nevertheless, policies, legislation, and decisions to allocate funds for research disregard that fundamental fact. The Northern Inland Waters Act, the Environmental Assessment and Review Process, and the Territorial Land Use Regulations address only questions of the second category. They thereby spawn a flurry of impact studies which, of necessity, must generally begin by collecting the simplest of baseline data in the shortest possible time. With respect to terrain and vegetation, studies have tended to concentrate on sensitivity to disturbance from construction activities; but we know relatively little about natural disturbances, rates of change, or time scales involved. With respect to wildlife, studies have concentrated on estimates of population size, and on classification of habitat and identification of areas that are critical or important for certain activities, such as overwintering or spawning. Mobility, complexity of behaviour, and wide fluctuations in numbers of wildlife populations present research problems over and above those encountered in relation to terrain and vegetation. Studies at the level of communities and ecosystems are virtually non-existent. To predict effects of activities, it often becomes necessary to extrapolate from studies that have been undertaken in other regions without the means of evaluating whether such information is applicable. Where an area is subjected to an invasion of scientists all pursuing their separate goals under similar time constraints, then the impact studies themselves can create an impact on the resources being studied.

An example of the kinds of questions that such reactive studies are expected to answer is illustrated in the objectives and terms of reference for a "Study of the effects of resource exploration and development on hunting and trapping and on the traditional economy of the Inuit in the Baker Lake area."[212] The final report of this study is to be submitted by 28 February 1978. Information about possible conflicts must be gathered by monitoring activities in a specified area during the period of the study. The contract for the study was awarded in the last part of June 1977 – after the spring migration of caribou, after calving, and probably after the formation of post-calving concentrations. The field data that can be obtained on the Beverly and Kaminuriak caribou herds are accordingly severely limited and must be collected while non-renewable resource activities are in progress. Historical documents, information from Inuit, and studies of barren ground caribou undertaken by biologists demonstrate that wintering areas, migration routes, calving areas, summer movements and, to a lesser extent, even traditional crossing places may vary from year to year. The numbers of populations fluctuate and the magnitude of their range varies. Yet, unable to consider a multitude of variables, unable even to address, much less answer, the numerous questions and hypotheses raised by the Kaminuriak herd study, this seven-month impact study is expected to reach definitive conclusions about the exact location of areas that are critical, important, or of no significance – not to the resource – but to present levels of hunting by Baker Lake Inuit. Similar conclusions must be reached about furbearing animals, fish, and waterfowl. The food and cash value of these resources will inevitably be underestimated, since the study is only concerned with Inuit from Baker Lake and not Inuit from settlements such as Chesterfield Inlet, Rankin Inlet, and Eskimo Point, nor with Indians in northern Manitoba and Saskatchewan.

Furthermore, during this seven-month period, an assessment must be made of the immediate and cumulative impact of current and anticipated non-renewable resource activities. If the cumulative impact of activities associated with non-renewable resource activities in the Mackenzie Valley could not be assessed after four years of impact studies, it is unlikely that a single seven-month study will succeed in the District of Keewatin. While Mr Allmand must be applauded for having had the courage actually to enforce existing Territorial Land Use Regulations against opposition from the mining industry, the time frame and terms of reference for the necessary study are totally unrealistic. As the proposal stated, "time is of the essence," and therein lies the root of the problem. The extractive industries are organized in such a way that they can only function to the economic imperative of maximum rate of depletion preceded by intensive exploratory activity. Given the assumption that this is desirable, then the long-term diverse values of renewable resources must be discounted in favour of short-term monetary profit. The whole perspective of resource use is accordingly biased.

In a study of *Land Use and Public Policy in Northern Canada*, John Naysmith observed:

> *Beginning with the Dominion Lands Act, public land policy in the North has been essentially a series of responses to demands for land, rather than a framework within which decisions respecting use and management are made on the basis of the land itself.*[213]

Naysmith recommended that a land use policy be based first on a consideration of the nature, capability, and limitations of the land. The premise that a knowledge of the nature, capability, and limitations of northern land is fundamental to the process of northern resource and land use planning would seem to be unarguable. But attainment of such knowledge requires allocation of land and funds for long-term co-ordinated research. An approach that emphasizes inventories will achieve compilation of much necessary data, but will not address questions related to the functioning of biotic communities within northern ecosystems. Naysmith suggested that the allocation of land for public purposes, including the establishment of International Biological Programme sites for scientific purposes, be considered together with the allocation of land to native peoples and the allocation of land for industrial and public works developments. While native land claims are being negotiated, and industrial and public works projects are the subject of intensive debate, the allocation of land for public purposes is not receiving similar consideration, if it is receiving any consideration at all. Decisions regarding the establishment of IBP sites in the North have been indefinitely postponed. The establishment of such sites would provide areas for long-term studies of relationships and balancing forces, or feedback mechanisms, in relatively undisturbed ecosystems. The sites would provide the baseline necessary to answer questions related to impact at the level of communities, rather than selected components of communities, and would therefore allow the evaluation of recovery processes in ecosystems that have been extensively modified by man. In addition, they would allow preservation of a diversity of genetic information contained in species of plants and animals that have evolved together and are adapted to constraints of the northern environment.

Provision for impact studies implies an acceptance of responsibility for trying to understand the effects of our actions. Yet we continue to deny ourselves the means for such understanding — the yardstick against which such effects may be measured. The practical application of long-term research is not limited only to predicting the effects of industrial or public works developments. It has a far broader application for the exploration of resource use options and ways of living associated with such options. An understanding of the productive capacity of the lands and waters of the North is essential for the maintenance of a subsistence economy. Because such capacity constitutes a range that will vary from year to year, from decade to decade, and from region to region, we need to know not the maximum sustainable yield, but the minimum sustainable yield. Can we increase this yield sometimes for some resources, without destroying other resources or the capacity of natural cycles to function? Without destroying the productive capacity of those lands and waters?

(b) Needs for Research and Policy Changes

A review of relevant literature is a prerequisite for research of all kinds. It is also essential for the identification of specific knowledge gaps and research needs. The searching component of the review process would be facilitated by computerized data banks which include publications that are limited in distribution, such as consultants' reports. However, the evaluation component of the review process can never be computerized. Evaluation of the limitations and applicability of results of published research is dependent on an understanding of the methods used and familiarity with the fields of research that are being considered. Prediction of conflicts from available information therefore requires an interdisciplinary approach, since the subject matter relevant to resources ranges from engineering design and industrial practices through all branches of the biological and social sciences. While such an approach is saving in time and money, it is not proposed that it be a substitute for field research and local information. These latter will always be of paramount importance.

Maintenance of a diversity of options dependent on renewable resources requires further development of the ability to predict the effects of natural and man-made changes on movements, numbers, variations in recruitment, and health of different populations of animals. The ability to predict clearly involves monitoring a number of parameters as a continuing process. Such monitoring should, where possible, make use of the least destructive or disturbing techniques. Measurement of diverse parameters is also essential to estimate changes in carrying capacity. And finally, accurate information from harvests is required, including data on the expenditure of time and effort in relation to the number of animals killed.

Management of wildlife resources would seem to require a sharing of the perspective of scientists with the perspective of such individuals of Indian, Inuit, Metis, and other origin who spend, or have spent much of their lives on the land. Identification and discussion of problems and ways in which they might be solved must involve people who are most directly affected by those problems. The languages of the Inuit, for example, contain systems of naming that are in themselves detailed forms of classification. Names for different kinds of snow indicate both properties and causes. Names for lairs made by seals indicate forms and functions. On the other hand, concepts related to migratory birds are based on knowledge that is not restricted to observations in the North. There is a need for the development of an indigenous research capability, which involves many people with different levels of knowledge and experience. Such development would not be easy, but it would seek to combine knowledge traditional to northern cultures with knowledge traditional to other cultures. Ultimately, this question must be resolved by the evolution of an appropriate system of education. But, in the meantime, it would seem desirable to develop the existing human potential.

Dependence on renewable resources raises the question of how much emphasis should be placed on recycling components of renewable resources. Another question relates to the fact that many of the traditionally harvested wildlife species of the North are either migratory or highly mobile. It is natural to think that if such harvesting was traditionally unrestrained, it can continue to be so. In consequence, all peoples in regions traversed or used by such species will consider their rights to be inviolate, to the detriment of the species. Indians of northern Manitoba and Saskatchewan may wish to increase their harvest of the caribou that winter in that region, while Inuit from Keewatin may wish to increase their harvest of the same caribou as they migrate north or south. Similarly, calving and post-calving concentration areas are important to Indians as well as to Inuit; and winter ranges in Manitoba and Saskatchewan are important to Inuit as well as to Indians. We cannot, in anything but a legal sense, possess anything living, if only for the fact that the living can die and death makes a mockery of our illusion of possession. Migratory species, like all wildlife, belong to no man. In a legal sense they belong to the Crown, but such ownership is defined as holding in trust. What is held in trust is not the individual but the species, which means ensuring that populations do not fall below a certain level. Conflicts are inherent in two concepts of legal ownership – ownership as a right of disposal and ownership as a responsibility.

Clearly, there is an urgent need for legislation that will protect migratory or highly mobile species. Comparable protection is also needed to safeguard the areas that are critical to them, and to ensure their unhindered access to those areas. Such legislation can only be based on an understanding of their behaviour and needs, and will be ineffective unless there is a general acceptance of the need for legislation. If wildlife management has been inadequate in the past, it has been in large measure due to a lack of funding for research and for sufficient personnel.[214] A change of policy is clearly required to ensure that such funding is adequate. When extended to other areas, such as climatology and oceanography, there is potential for creating employment for northerners, which would be long-lasting, and infinitely more productive in human terms than the payment of welfare.

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